CHEMISTRY

INSTRUCTION BOOK

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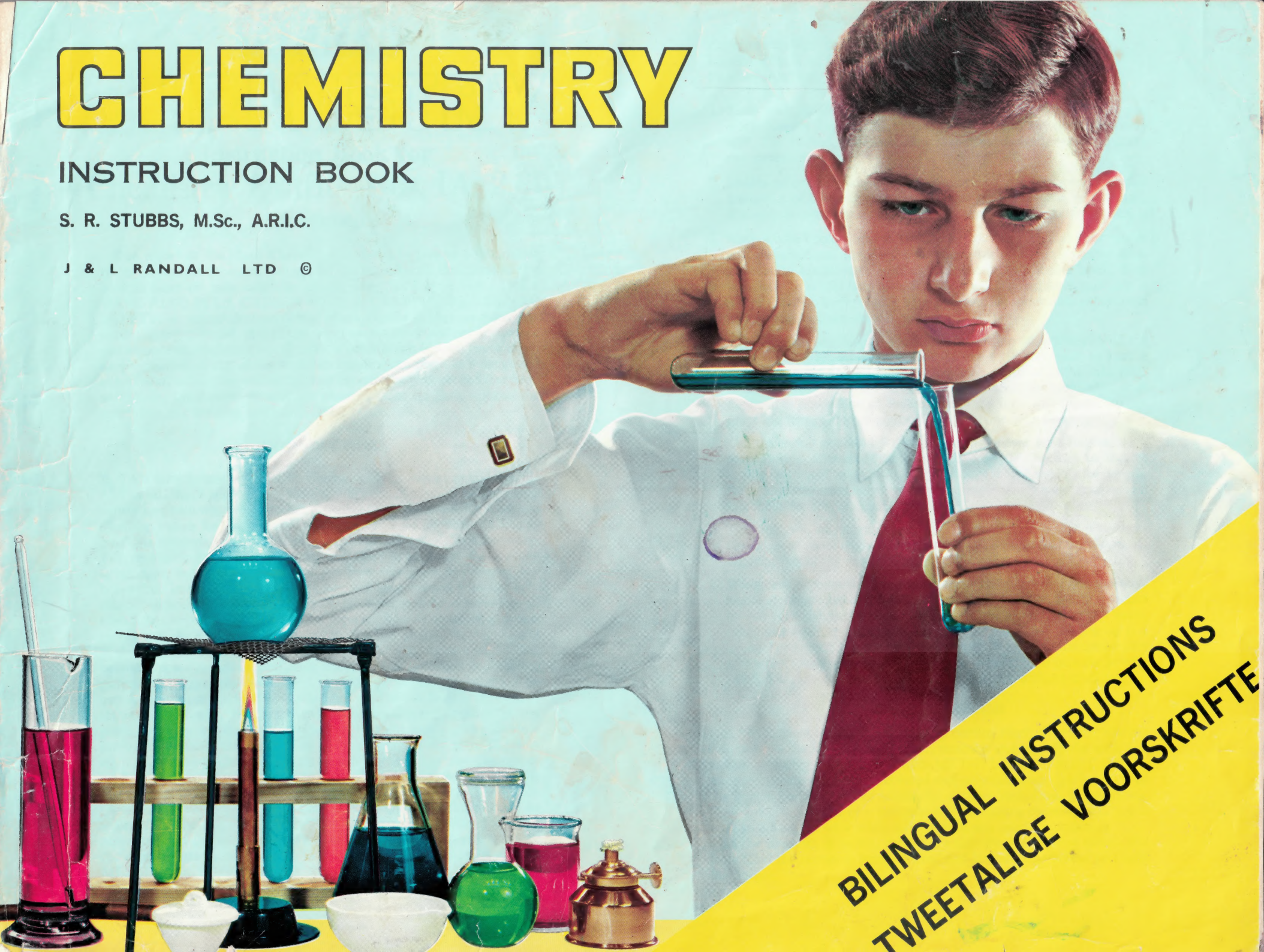


BILINGUAL INSTRUCTIONS
TWEETALIGE VOORSKRIFTE

7" S.P.

MERIT

CHEMISTRY

Instruction Book for

Chemistry Outfits Nos. 1A, 2, 3

FOREWORD

The object of the Merit Chemistry Outfits is to give to a fascinating hobby a real instructional value, and the experiments described in this booklet have all been carefully chosen with this end in view. THEY HAVE ALSO BEEN CHOSEN WITH A CAREFUL REGARD TO SAFETY. A special feature of the Merit Outfits is that **no dangerous** materials are included, and all the experiments described can be carried out without the slightest risk. Further, a point which is often overlooked, **no combination of any of the materials supplied can result in a dangerous experiment,** so that the enthusiast may experiment with perfect freedom, so deriving the greatest benefit and pleasure from the Sets, without the possibility of obtaining some unpleasant result.

INTRODUCTION

MAN is by nature an inquisitive being, and it is not surprising that he should have spent much time and energy in a study of the many substances with which Nature has provided him—materials for food and clothing, metals for use and ornament, medicines for his ailments, and so on. This examination of substances is, simply, the study of Chemistry. For centuries, comparatively little was discovered about these many substances, but the discoveries of the past 100 years are almost unbelievable. In these discoveries man has not been content with the substances provided by Nature—he has, by increasing his knowledge of Chemistry, improved on them, and discovered how to make entirely new substances in his laboratories—substances of which Nature knows nothing. These discoveries have given us safer and better anaesthetics, beautiful new dyes, steels, and other alloys for a multitude of engineering purposes, new materials with which to clothe ourselves—the list could be extended for pages. It is little wonder that the chemist finds every kind of interest in his work, for Chemistry is as fascinating and thrilling as any game, and you will find that, studied in the right way, it can provide a hobby, if no more, second to none in the pleasure it can give. The only right way to study Chemistry is by experiment, and the new discoveries we have mentioned were not made simply by thinking about them—the key to knowledge was experiment, and the best of all experiments are those you do yourself. You will find in the simplest experiment done by yourself for the first time, the thrill of real discovery. Before you start, however, read the following advice carefully. It will help you to make the experiments successful, and to get the greatest pleasure from your MERIT Outfit.

Experiments Nos. 1 – 39 can be performed with Outfit No. 1A
Experiments Nos. 1 – 90 can be performed with Outfit No. 2
Experiments Nos. 1 – 131 can be performed with Outfit No. 3

1. Keep your hands clean, and also the bench or table at which you work. Keep a duster at hand to wipe up at once any liquid you may spill. The kitchen, garage or attic is the best room in which to carry out experiments.
2. Unless otherwise advised for some particular experiments, use small quantities of the materials—make your solutions weak or "dilute". Not only is this more economical—it usually gives far better results.
3. Keep a note book to record the experiments you do, and your results and observations. Just as the photographer or stamp collector finds pleasure in his albums, so does the chemist in his note book. You will find this a real help also, for often when doing an experiment it is very useful to know exactly what happened in some other experiment you may have done some time ago.
4. When heating anything in a test tube or heating tube, always hold the tube in the wire test tube holder provided. If you want to heat a mixture of solid and liquid in a tube, put the liquid in the tube first, so that the solid does not "clog" at the bottom of the tube. Also, start the heating gently, heat at the bottom of the tube, and finally, do not point the tube, either at yourself or at anyone near you.
5. Use the scoop provided for all chemicals—never your fingers. As a rough guide, whenever you are advised in this booklet to use "a little" or "small quantity", half a scoopful will usually be ample. Return unused material at once to its proper container. Clean out all apparatus before you put it away.
6. You will not, of course, taste any of the chemicals, for you know that some of them might make you very ill. Be sure that the chemicals are kept out of the reach of young children.
7. When heating substances in test tubes, or any other glassware, always ensure that the application of heat is gradual. Initially, the tube should be put into the flame, then removed for an instant, then put back, taken out again momentarily, and so on so that the heating up is a gradual process. Similarly the glass should be put into the cooler part of the flame to start with, and then gradually brought into the hottest point. This process enables the glass to expand without cracking.

THE SPIRIT BURNER

A Merit spirit burner is provided in certain Merit Chemistry Outfits (see page 1). To fill the spirit burner, unscrew and remove the wick and holder assembly. After filling with METHYLATED SPIRIT ONLY, ensure that this assembly is replaced and screwed down tightly and wipe the burner body dry. Then adjust the wick so that about $\frac{1}{8}''$ protrudes. This will give a flame of a size suitable for heating experiments. If you wish to adjust the wick while it is burning you must use tweezers.

In the interests of safety, make sure that the bottle from which you have filled the burner is firmly corked and stored away before you light the burner.

HOW TO MAKE CRYSTALS

The making and examination of crystals is one of the most fascinating parts of Chemistry. Crystals are formed in all sorts of shapes and colours, and you may find natural ones amongst rocks, or in coarse sand from the sea shore or the bed of a stream. The following experiments tell you how to make some yourself.

Experiment 1.—Place a little water in a test tube (to a depth of about 1 in.), and add a small amount of copper sulphate. Now heat gently until the tube is comfortably warm to touch (do not get it too hot). The copper sulphate dissolves. Add a little more, which should also dissolve, and continue this process until the last lot added either will not dissolve, or dissolves very slowly. During the whole of this operation, keep the tube gently shaken. You now have a "saturated" solution of the copper sulphate. Carefully pour the clear liquid from the tube on to the watch glass provided in your Outfit, and leave it to stand and cool for some time without disturbing it. Small blue, diamond-shaped crystals should soon form. Examine these carefully—use a magnifying glass if you have one. You can now pour off the liquid, and place the crystals on blotting paper to dry, and then, if you do not want to keep them, put them back in your stock.

Experiment 2.—Repeat Experiment 1 exactly, but use alum in place of copper sulphate. You should obtain crystals of the shape shown in Fig. 1.

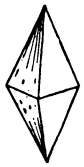


Fig. 1
Alum Crystal

Do the experiment again also with magnesium sulphate.

Experiment 3.—If you have a small microscope (our Merit Microscopes are excellent ones for general use), examine the formation of crystals by making a little warm, saturated solution of copper sulphate, alum, or any of the other substances mentioned above. Place two or three drops of this warm solution on a microscope slide, and examine the crystals with the microscope as they form.

Experiment 4.—"How to Grow" a Large Crystal. Make about half a test tube full of saturated alum solution as before. Pour this solution, when cold, into an egg cup or small tumbler. If the solution is not clear, you had better filter it before going any further (see Experiment 7). Now pick out a good shaped alum crystal from Experiment 2, and place it in the saturated solution. Leave in a cool place, and turn the crystal over to a fresh "face" every day. You should be able to grow quite a large crystal of the shape shown.

Experiment 5.—Place a little copper sulphate in one of the spare test tubes, which are usually used for heating solids. Hold the tube in the test tube holder, and heat gently. Steam is given off—the copper sulphate contains some water which is called "water of crystallisation" and the blue solid turns white. Now allow the tube to go quite cold, then add just one or two drops of water. The white solid turns blue again.

Experiment 6.—Try the previous experiment with cobalt chloride. In this case the pink solid turns blue as water of crystallisation is driven out. This experiment will explain the use of cobalt chloride as an invisible ink in Experiment 35. Not all crystals contain water of crystallisation. Try to find out for yourself whether alum, and ordinary table salt, do or not.

ACIDS, ALKALIS, AND INDICATORS

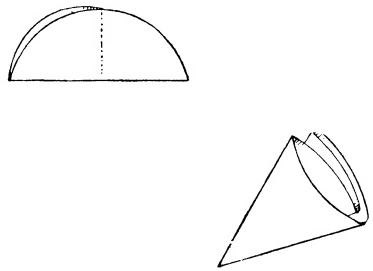


Fig. 2
Folding a Filter Paper

Experiment 7.—About half fill a test tube with water, add a little litmus powder and warm. Fit the filter funnel with a filter paper (the method of folding the paper is shown in the diagram), and pour the litmus solution into the paper in the funnel, collecting the liquid which runs through in a clean test tube. You should obtain after this filtration a clear, purple liquid which will be required in many future experiments. Small medicine bottles are useful for storing liquid like this.

Experiment 8.—Repeat the above preparation with logwood, and store the liquid obtained. This will also be required in future experiments.

Experiment 9.—Make a little dilute solution of tartaric acid, and add a few drops to a little litmus solution in a test tube. The blue or purple litmus is turned red, a colour change which is explained below (Experiment 13).

Experiment 10.—Try the effect of adding vinegar, and lemon juice, and other fruit juices, to litmus solution. Vinegar contains an acid called acetic acid, whilst lemon juice contains citric acid.

Experiment 11.—Make a solution of litmus just red by adding one drop of vinegar. Pour a little of this solution into another tube, and add a little slaked lime (calcium hydroxide, to give it its proper chemical name). This time the red solution turns blue. A substance like slaked lime, which turns red litmus blue, is called an **alkali.**

Experiment 12.—You will very probably have in the house both ammonia and washing soda. Try the effect of these on litmus solution—these substances are also alkalis.

Experiment 13.—Try the effects of the acids and alkalis mentioned in Experiments 9 to 12 on logwood solution. Acid turns this solution yellow, whilst alkalis turn it blue. Substances like litmus and logwood, which give different colours with acids and alkalis, are called **indicators.** The coloured juices from many plants, fruits and berries will act as indicators. Try the effect of acids and alkalis on raspberry and blackcurrant juice, blackberry, elderberry and beetroot. (An easy way to get some of these is to shake a spoonful of the fruit jam with water, and filter to obtain the clear, coloured liquid.)

Experiment 14.—It is often more convenient to use litmus papers than the solution. You can make these by soaking filter paper or white blotting paper in the litmus solution. Allow to dry, and cut the paper into small strips. Make both red and blue litmus papers in this way, using the red solution from Experiment 11. Litmus papers are also provided in the Outfit.

HOW TO DETECT REAL AND ARTIFICIAL SILK

Experiment 15.—Heat a small piece of real silk in a dry tube, and hold a piece of moist red litmus paper at the mouth of the tube in the vapours given off. The paper is turned blue by ammonia, an alkaline gas, which is given off. Now try the experiment with a piece of artificial silk, but use blue litmus paper. In this case acid vapours are given off, and the paper is turned red.

The explanation of these results is that animal fibres, like wool and real silk, contain the element nitrogen (this is also one of the gases present in air), and when these materials are heated, ammonia gas, which contains nitrogen, is given off. On the other hand, cotton and artificial silk (which is made from cotton) are of vegetable origin, contain no nitrogen, and when heated give off acid vapours.

Experiment 16.—Try Experiment 15 with wool, cotton, linen, string, leather, and see if you can decide which are likely to be of animal, and which of vegetable origin.

EXPERIMENTS WITH OXYGEN

The importance of the gas **oxygen** in air is a matter of common knowledge. Without this gas, life as we know it would be impossible. Taken into our lungs with every breath of air, it is carried by the blood to every part of the body, burning up waste matter, and forming in the process another gas called carbon dioxide, which is breathed out. Airmen flying in a rarefied atmosphere at high altitudes carry their own supply of oxygen, and the gas is also supplied in hospitals to patients suffering from affections of the lungs. Just as the gas facilitates breathing, so also does it aid burning, giving rise to much more intense combustion than ordinary air, a fact which explains its use in the oxy-acetylene blowpipe.

You can obtain oxygen from materials usually to be found in most households—hydrogen peroxide solution, and the bleaching or disinfecting solutions of the hypochlorite type (e.g., Milton). If no solution of this type is available, Experiment 29 will explain how to make a substance which will serve for our purpose.

Experiment 17.—Before you start this experiment, have a wood splint ready, such as is used as a pipe lighter. (A match stick will not do, as this is specially impregnated to prevent it glowing). Place a little hydrogen peroxide solution in a test tube and add a few drops of hypochlorite solution (e.g., Milton). A vigorous fizzing action or "effervescence" takes place, and oxygen is given off. Immediately light the splint, then blow out the flame, and place the glowing splint in the mouth of the test tube. It will immediately burst into flame, burning brilliantly in the oxygen.

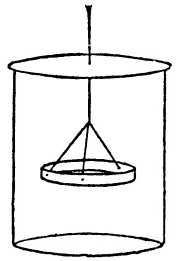


Fig. 3

Experiment 18.—Obtain a small tin lid, punch three holes at the sides, and support the lid by thin wire as shown in Fig. 3. Place a short piece of candle on the lid and light it. The supporting wire from the tin passes through a piece of cardboard, so that when the lid is placed in a jam jar the jar is kept covered during the experiment. Place a little hydrogen peroxide solution in the jar, and add a few drops of hypochlorite solution, when the jar will rapidly fill with oxygen. Now lower the tin lid and candle into the jar, and notice how brilliantly the candle burns in oxygen.

Experiment 19.—For this experiment you do not require the tin lid, but use the cardboard cover, and fill a jar with oxygen as described above. Now using a pair of pliers, hold a length of the fine iron wire provided, and heat the end. When the wire glows, place it quickly in the jar of oxygen and see how brilliantly the wire sparkles. Even a metal like iron will burn in oxygen!

HOW TO FIND THE AMOUNT OF OXYGEN IN AIR

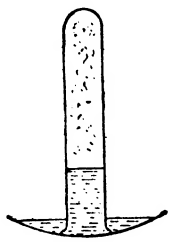


Fig. 4
Iron rusting in a tube over water

Experiment 20.—Wet the inside of a test tube, and sprinkle in some iron filings, which will stick to the wet side of the tube. Stand the tube upright with its mouth in a shallow dish or saucer of water, and leave it for two or three days (Fig. 4).

As the iron rusts, it combines with oxygen in the air.

As the oxygen in the tube gets used up, water rises in the tube. You will find that the water will rise about one-fifth of the way up the tube, and then will rise no further. This fraction represents the proportion of oxygen in air. Just as metals require oxygen in order to burn or rust, so animals (*including human beings*) require it in the process of respiration or breathing, and strangely enough the two processes are rather similar. For the next few experiments, which will tell you more about this, you will require some lime water, which is made in the following way.

Experiment 21.—Thoroughly shake up in a bottle some slaked lime with water. Filter the liquid into a clean bottle, and label it. You can put the solid in the filter paper back into the first bottle, and shake it up with water again so as to obtain more lime water, which is filtered as before.

Experiment 22.—Place a short candle end on the lid used in Experiment 18, light it, and lower it into a jam jar. When the flame goes out, remove the candle, pour some lime water into the jam jar, cover it, and shake up. The lime water goes milky white in colour—a change brought about by the gas carbon dioxide. This gas has been formed by carbon from the candle wax combining with oxygen in the air as the candle burns.

Experiment 23.—Place a little lime water on a watch glass, and simply leave it in the air for a day or so. The lime water also turns slightly milky, showing that carbon dioxide is present in air. The milkiness in the lime water is brought about by carbon dioxide combining with the slaked lime (calcium hydroxide) forming calcium carbonate, or chalk, and this, being insoluble, makes the liquid milky or turbid.

Experiment 24.—About one-third fill a test tube with lime water, and gently blow into the solution through a glass tube. (A tube used for such a purpose should of course be perfectly clean, and should have the edges rounded off by heating in a flame to soften the glass.) The lime water in this experiment also turns milky, showing that the air you breathe out contains carbon dioxide. The air you breathe in contains oxygen, which turns some carbon in your body into carbon dioxide, which you then breathe out—a process very similar to the burning of the candle in Experiment 22.

COMPOUNDS CHANGING PARTNERS

You will have noticed that compounds, like people, have a first and second name, and when mixed in solution, many compounds seem to like to change their names, and make entirely new compounds. It is just as though two boys, Tom Brown and Joe Smith, getting thoroughly mixed up in a fight, come out of it as two entirely different boys like this:

Tom Brown + Joe Smith = Joe Brown + Tom Smith.

You can see this sort of change in the next experiment.

Experiment 25.—Make a little solution of copper sulphate in a test tube, and add some calcium hydroxide solution (i.e., lime water) to it. Two new substances are formed in the way just explained, copper hydroxide and calcium sulphate.

Copper Sulphate + Calcium Hydroxide
= Copper Hydroxide + Calcium Sulphate.

The copper hydroxide, however, is insoluble, and so it cannot stay in the solution—it appears in the form of a blue "precipitate".

As a general rule, if solutions of two substances are mixed, and an insoluble substance can be formed by an exchange of partners, then this substance will be precipitated.

Experiment 26.—You can take the previous experiment a stage further by carefully boiling the liquid containing the blue precipitate of copper hydroxide. You will find that the precipitate gradually darkens in colour and finally turns black—it is now copper oxide. (If this experiment does not work very well, it is because you have used too little lime water. Try again with less copper sulphate and more lime water.)

Experiment 27.—The partner-exchange sort of action (the proper chemical term is "double decomposition") is illustrated by a beautiful little experiment in the following way. Make a little alum solution (the important part of which is aluminium sulphate) in a test tube, and add some lime water as before. Again by an exchange, aluminium hydroxide is formed and precipitated, and appears as a rather faint, white precipitate. You will probably have to examine the liquid carefully to see the precipitate. Now, however, add some litmus solution, and heat the tube carefully, then allow to cool. The precipitate absorbs some of the litmus, and now settles down as a beautiful blue precipitate.

Experiment 28.—Try a double decomposition experiment with lime water and cobalt chloride solution, and so find out for yourself the colour of cobalt hydroxide.

Experiment 29.—Do Experiment 28 again, using manganese sulphate solution in place of cobalt chloride. This time a "flesh" coloured precipitate of manganese hydroxide is obtained. Now if you have any hydrogen peroxide solution, place some of this in a test tube, shake up the precipitate and liquid you have just prepared and add some of this mixture to the peroxide solution. The pale coloured precipitate immediately turns

black, the whole mixture froths up, and **oxygen** is given off, as you can test with a glowing splint. This experiment explains how to obtain oxygen from hydrogen peroxide, so that a precipitate of manganese hydroxide prepared as just described can be used in place of the hypochlorite solution in Experiment 18.

Experiment 30.—Most interesting experiments on double decompositions can be carried out with some of the materials in your Outfit, together with the easily obtained substance known as "water glass". This substance, sold in the form of a syrup, is commonly used for preserving eggs, and its chemical name is **sodium silicate.**

Make a solution of a tablespoonful of water glass in a cupful of warm water, and allow the solution to cool.

Place a little of the water glass solution prepared as above in a test tube, and add a little magnesium sulphate solution. A white precipitate of magnesium silicate is obtained. Try the same experiment with copper sulphate, manganese sulphate, and cobalt chloride solutions. These substances form beautifully coloured precipitates of copper silicate, manganese silicate and cobalt silicate respectively.

Experiment 31.—The Chemical Garden. You may use the remainder of the water glass solution made in Experiment 30 to carry out a most effective and colourful experiment. Place the water glass solution in a glass tumbler, and add very small fragments—pieces little larger than a pin head—of copper sulphate, manganese sulphate, magnesium sulphate, alum, and cobalt chloride, and observe the results carefully from time to time.

Even after a few minutes thread-like growths appear from the magnesium sulphate, and alum particles, coloured growths from the other substances appearing more slowly. After some time the "threads" branch out in all directions, until after a day or so the effect is produced of a colourful and luxuriant plant-like scene under water. The "growths" are due to the formation of the coloured insoluble metal silicates, and the result clearly explains the term "The Chemical Garden" applied to the experiment.

Experiment 32.—Make a little dilute copper sulphate solution in a test tube, and add a very little iron filings. In this experiment iron changes place with copper in the solution. The solution goes paler and paler, and copper takes the place of iron at the bottom of the tube. (The solid left may not look like copper, as it is in a very fine form, and may appear nearly black.)

Experiment 33.—Make a dilute solution of copper sulphate, and place in it, for a few moments only, a piece of bright iron, or a pen-knife blade. The same action as in Experiment 32 proceeds, but this time the copper is deposited on the iron as a lovely brown coat—the iron is copper plated. The plating, however, is not very firm, and can easily be polished off.

INVISIBLE INKS AND SECRET WRITING

Experiment 34.—Make a dilute solution of copper sulphate, and use this to write on a sheet of paper, using a clean nib. When dry, the writing should be invisible, but it can be made visible, or developed, either by warming the paper near a flame, when the writing will show up brown, or by carefully dabbing it with a cloth pad moistened with ammonia when it will show up blue.

Experiment 35.—Write with a dilute cobalt chloride solution. When dry, warm near a flame, when the writing will show up blue.

Experiment 36.—Although not so good as the above, try writing with milk, or lemon juice as invisible inks. The writing is again developed in both cases by warming near a flame.

THE FLAME TEST TO DETECT A METAL IN A COMPOUND

Experiment 37.—An interesting fact that can be made use of to detect the metal in a compound is that when the compounds are placed in a flame, different metals will colour the flame differently. Some, however, do not colour the flame at all.

Place a small pinch of salt (sodium chloride) on the tip of a pen-knife blade, and place it in the spirit lamp or bunsen flame or the flame of an ordinary gas ring. The flame is coloured an intense yellow. Try with washing soda—the same intense yellow is produced—washing soda is sodium carbonate. Any sodium compound will give the same yellow colour.

Try this again with copper sulphate. This time a bright blue-green colour is obtained. With calcium compounds (use slaked lime, i.e., calcium hydroxide), an orange colour is formed.

A MINIATURE GAS WORKS

For this experiment a test tube must be sacrificed, but it is very well worth while.

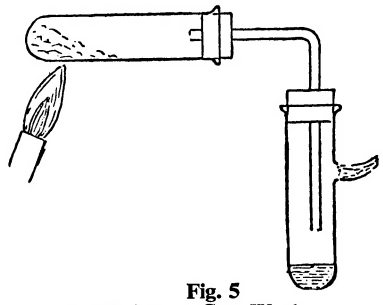


Fig. 5
A Miniature Gas Works

Experiment 38.—First of all fit a test tube with a one-holed cork carrying a short, straight length of glass tubing. Heat the tube, on the side only, at a point near the middle, and at the same time blow into the tube, when the glass is soft. In this way you will be able to blow a hole in the side of the tube.

Now fit another tube with a one-holed cork, carrying a glass tube bent at right angles, which

also passes through a cork into the test tube in which you have just blown a hole (Fig. 5). About one-third fill the horizontal tube with powdered coal, and heat, at first gently, then more strongly. Very soon a brown vapour enters the vertical tube, in which also a liquid begins to condense. Gas (impure coal gas) issues from the hole blown in the side of the tube—put a lighted match to this, and you will find that it will burn. The brown, oily liquid which collects in the tube is coal tar—one of the most valuable "by-products" of the coal industry. Many substances are obtained from coal tar, including benzene and phenol or carbolic acid, from which in turn are obtained dyes, drugs, and explosives of all kinds. The watery liquid, which you should also notice, contains ammonia. Coke is left in the horizontal tube.

Experiment 39.—Repeat the previous experiment, but use small bits of wood in place of coal. The liquid now collected contains acetic acid (the same as is present in vinegar) and methyl alcohol, which is used in methylated spirit. The gas which issues from the side of the tube will burn like coal gas. Wood charcoal is left in the horizontal tube.

(End of experiments possible with Outfit No. 1A).

THE BUNSEN BURNER

The Bunsen Burner is one of the chemist's most important instruments. With it all heating experiments can be more simply and efficiently carried out, and the bunsen flame itself is well worth careful examination. (SPIRIT BURNER—see page 3.) THE BUNSEN BURNER PROVIDED WITH OUTFITS NOS. 4 AND 5 IS SUITABLE FOR USE WITH COAL GAS ONLY AND SHOULD NOT BE USED WITH NATURAL OR METHANE GAS.

Experiment 40.—Examine your bunsen flame, with the air hole at the bottom closed. The flame is yellow, not very hot, and luminous, i.e., light-giving. Open the air hole, and notice how the flame changes. It is now non-luminous, and much hotter.

Sprinkle a few iron filings through this flame. Each particle as it falls through the flame glows brilliantly. Solid particles in the flame make it luminous.

MAKING A GAS-MANTLE

Experiment 41.—Place about a saltspoonful of slaked lime in an evaporating dish, and cover with vinegar. Warm this mixture a little, and then soak it in a piece of cotton—a short length cut from a roll of bandage serves very well. Squeeze out the surplus liquid, and hold the cotton in a pair of tongs in the bunsen flame. The cotton dries and burns away, but delicate filaments of lime are left, which glow with a beautiful white light. This experiment is particularly striking in a dark room, and illustrates well how a gas-mantle works.

Experiment 42.—The non-luminous bunsen flame consists of two cones. The inner cone is cold, and contains unburnt gas. You can show this by holding a match stick across the flame for two or three seconds. When you take it out, it is charred where it was in the outer cone, but the part which was in the inner cone is uncharred. Now turn out the bunsen, stick a pin through a match near the head, and place the match stick in the bunsen tube; the pin across the top of the tube will hold it in position. Now turn on the gas and light it. The match head should now be in the inner cone, and will not ignite if it is centrally placed.

In most heating experiments, use the non-luminous flame. The luminous flame will deposit soot on objects heated in it.

BENDING, CUTTING, AND DRAWING GLASS TUBING

Experiment 43.—To bend glass tubing, a "fish-tail" flame is best, and you can obtain this by using a burner attachment. Hold the tube along the top of the flame, rotating it slowly at first. Now hold it lower in the flame when it will begin to bend under its own weight. Do not use any force, and allow the tube to cool slowly by holding it over the flame for a little while before removing it completely. To cut a tube, draw a file sharply across it to make a little nick, then holding the tube in a cloth, break it at this point as you would break a match stick.

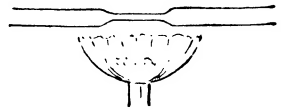


Fig. 6

Experiment 44.—You will require for various experiments a tube drawn out to a point, and you can make a tube like this in the following way. Heat a length of glass tubing along the top of the flame as before, rotating it continually, and when the glass is felt to be soft, pull firmly, and not too quickly. The glass will draw out into the shape shown in Fig. 6. Cut the tube in the middle, and so obtain two drawn-out tubes. The sharp edges of all glass tubing should be rounded off by heating at the edge of the flame for a little while so as to soften the glass. If you continue to heat the end of the tube, continually rotating it, it will seal itself up.

HYDROGEN—THE LIGHTEST GAS

Experiment 45.—Make a little dilute solution of sodium bisulphate, and try the effect of this solution on litmus solution and on logwood. The results show the bisulphate to be acid—it behaves, in fact, like a dilute solution of the well-known sulphuric acid.

Experiment 46.—Make a little solution of sodium bisulphate in a test tube, and add a piece of granulated zinc. A drop of copper sulphate solution will speed up the action. The metal begins to dissolve, and bubbles of gas are given off. Place the mouth of the tube near a flame, when you should be able to make the gas burn with a blue flame, or perhaps explode with a squeaky pop. This gas is hydrogen, and is the lightest gas known.

Experiment 47.—Continue the previous experiment, and collect the hydrogen by pouring it **upwards** into another tube (Fig. 7). After a few moments place your thumb over the mouth of the collecting tube, and then again place it near a flame. If the gas you have collected is not pure, but mixed with air, it will explode with its peculiar squeak.

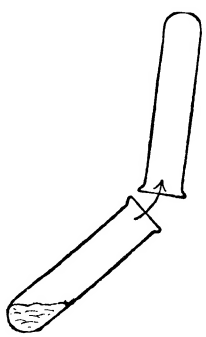


Fig. 7
Collecting Hydrogen by pouring the gas upwards

Experiment 48.—Hydrogen can be obtained by the action of the various acids on various metals. Try the experiment again, using iron filings in place of zinc. When you have finished with this experiment, do not throw the solution away—keep it for Experiment 49.

Also try the action of tartaric acid solution on zinc—in this case also a drop or two of copper sulphate solution added to the mixture will speed up the action.

Experiment 49.—Continuing the first part of Experiment 48, filter the solution from undissolved iron filings, and notice the pale green colour of the solution. Place the solution in a watch glass or shallow dish, and leave it for a few days to crystallise. You should obtain some green crystals of **ferrous sulphate, or green vitriol.** Pour any remaining liquid off the crystals, and dry them on blotting paper.

Experiment 50.—Make a solution of sodium bisulphate in a test tube, warm it, and add a little copper oxide. The black powder dissolves, forming a blue solution of copper sulphate. Continue adding copper oxide in small amounts until no more will dissolve, and then filter the solution into your porcelain dish. Again evaporate a little as before, and leave the solution to crystallise. Dry any crystals you obtain on blotting paper.

Experiment 51.—Make dilute solutions of copper sulphate and sodium carbonate (washing soda) in separate tubes, and then mix the solutions. A blue precipitate of copper carbonate is formed. Filter off this precipitate, and wash it by pouring clean water over the filter. Carefully remove the filter paper and precipitate from the funnel, place it on a clean sheet of paper, and leave it for some days to dry. You should then have a little copper carbonate as a fine blue powder, which you should keep for future use (e.g., Experiment 53).

Experiment 52.—By the method used in the previous experiment, obtain a white precipitate of magnesium carbonate, by mixing solutions of magnesium sulphate and sodium carbonate.

Experiment 53.—Put a glass tube into lime water, hold your finger over the top of the tube, and take the tube out of the liquid. By slackening your finger at the top of the tube, you can allow the lime water to run out, and with a very little practice you can hold a drop of lime water on the end of the tube without shaking it off. Practise this a little before going on with the experiment. Now put the copper carbonate you made in Experiment 51 in a small tube, and heat gently, holding a drop of lime water as you have practised at the mouth of the tube. The copper carbonate turns black, forming copper oxide and the drop of lime water turns milky, showing that carbon dioxide is given off. This method of testing for a gas is very useful when very little is likely to be present.

Experiment 54.—For this experiment the strongest heating is required. Half fill a crucible with marble chips (marble is calcium carbonate), and heat, at first gently, then as strongly as possible for at least an hour. (The bowl of a broken clay pipe, filled with marble chips, and placed in the middle of a glowing fire, will serve admirably for this experiment.) In this experiment, the calcium carbonate loses carbon dioxide, and the substance left is calcium oxide or quick lime.

Experiment 55.—Place the crucible (when quite cold) at arm's length away from you, and very cautiously add water to the quick lime, one drop at a time, using a "dropping tube" by the method you practised in Experiment 53. There is a violent action every time a drop of water falls on the quick lime, some of the added water is turned to steam, and the lime swells up. When the action is finished, the lime is said to be slaked, and the substance left is slaked lime, or calcium hydroxide. These experiments illustrate the way in which lime is manufactured by heating limestone (which is also calcium carbonate) in kilns. The quick lime formed is then slaked by adding water.

Experiment 56.—Although carbon dioxide can be driven out of a carbonate by heating it, a better method is to act on a carbonate with an acid.

Make a fairly strong solution of tartaric acid in a test tube, and add a small piece of marble. A fizzing action, or "effervescence", takes place, and you can show that carbon dioxide is being given off by holding a drop of lime water in the tube as before.

Experiment 57.—The same effervescence, with carbon dioxide given off is produced by most acids on any carbonate. Try with vinegar on sodium carbonate.

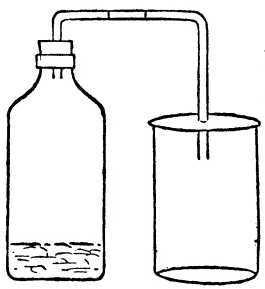


Fig. 8
Collecting a jar full of Carbon Dioxide

Experiment 58.—You can now collect several jars of carbon dioxide by fitting up a small medicine bottle with a one-holed cork and delivery tube as shown in Fig. 8. The "delivery" tube with a double bend is obtained by connecting together the two tubes provided with a short length of rubber connecting tubing. Place in the bottle some sodium carbonate (washing soda), cover this with tartaric acid solution, and replace the cork fitted with delivery tube quickly. You can find out when the jar is full of gas by holding a lighted match just at the top of the jar. The light will be extinguished when the jar is full.

Collect two or three jars of the gas, and cover each with a cardboard lid as you remove it. Notice that the delivery tube passes through a piece of paper which covers the jar during the experiment. The jars of gas collected may be used in Experiments 60 and 62.

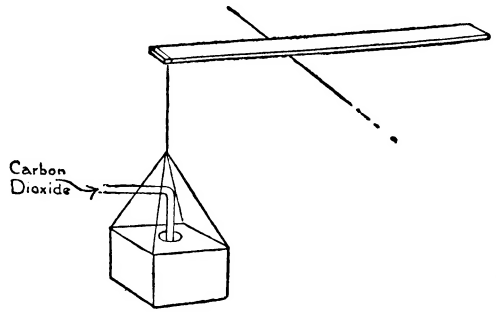


Fig. 9 Experiment to show that Carbon Dioxide is a very Heavy Gas

Experiment 59.—Make a paper box with a lid, and cut into the lid a hole about the size of a halfpenny. Tie the box on to the end of a light ruler, and balance the ruler on a fine edge, or on a pencil (Fig. 9). Now hold the end of the delivery tube from the carbon dioxide apparatus of the previous experiment over the hole so as to fill the box with the gas. The arrangement serves as a rough balance, quite good enough to show that carbon dioxide is a heavier gas than air.

Experiment 60.—You can also show what a heavy gas carbon dioxide is in the following way. Fill a wide-mouthed jam jar with the gas, using the apparatus of Experiment 58. Blow a soap bubble in the ordinary way, and shake the bubble into the jar. This requires a little care, but it is not very difficult. The bubble will float on the gas in the jar.

Experiment 61.—If a jar of carbon dioxide is left uncovered, then as you might expect, the gas simply mixes with air, and eventually disappears. The process by which gases mix up with each other is called "diffusion", and experiments have shown that heavy gases diffuse, or "mix up", more slowly than light gases. You can carry out an experiment on diffusion yourself by filling say four test tubes with carbon dioxide, using the apparatus in Fig. 8. Place the tubes full of gas in a stand, and uncover them all at the same time—you will require a watch with a seconds hand for this experiment. After say one minute, place a little lime water in the first tube, and shake up. You will probably find that carbon dioxide is still present in this tube by the lime water turning milky. After another minute try the second tube by adding lime water in the same way. If that still contains carbon dioxide, try the third tube after another minute, and so on. You will probably be surprised to find how long it takes the gas to diffuse away completely.

Experiment 62.—Place a short candle end on the table, light it, and "pour" carbon dioxide from a jar over the flame, just as if you were pouring a jar of water over it. The gas forms a sort of blanket over the flame, and so extinguishes it by excluding air. Certain types of small fire extinguishers used in many buildings make use of this principle. They contain an acid and sodium carbonate solution, which can be mixed at once when the extinguisher is in use, and so "spray" carbon dioxide over a flame.

Experiment 63.—Half fill a test tube with lime water, and place the delivery tube of the apparatus in Fig. 8 in this, so as to allow carbon dioxide to bubble through the lime water. The lime water turns milky, of course, but do not stop the experiment. After a little time the milkiness begins to disappear, and soon the lime water is as clear as when you started. The precipitate of chalk first formed when carbon dioxide is passed into lime water dissolves when more carbon dioxide is passed in; the substance now in solution is called calcium bicarbonate, i.e., calcium carbonate with an extra portion, as it were, of carbon dioxide. Keep this solution for the next experiments.

Experiment 64.—Place a little of the clear calcium bicarbonate solution from the previous experiment in a test tube, add a small piece or flake of soap, and shake up. Instead of getting a lather, you get a scum (or precipitate) formed on the water. Water which contains calcium bicarbonate, and which behaves like this with soap, is said to be "hard".

Experiment 65.—Place a little of the clear solution from Experiment 63 in a test tube, and boil. The extra carbon dioxide is driven off, calcium carbonate or chalk is reformed, and the liquid goes milky again. Filter this liquid, again add a little soap, and shake up. Now you get a lather—boiling the water has "softened" it.

Experiment 66.—To another portion of the calcium bicarbonate solution from Experiment 63 add some ammonia (household or a solution as made in Experiment 88). The liquid goes milky again, chalk being once more precipitated.

Experiment 67.—Finally, add some washing soda (sodium carbonate) solution to the calcium bicarbonate solution. Again a milkiness is produced by chalk being precipitated. This experiment and the previous one show one reason why ammonia or washing soda is often added to water used for washing purposes. If the water is hard, due to the presence of calcium bicarbonate these substances soften the water by precipitating chalk.

Experiment 68.—Test the water in your own house to see if it contains any calcium bicarbonate. Try as in the previous experiments (a) boiling some of the water, (b) adding washing soda, (c) adding ammonia. Note if any milkiness is produced by any of these methods. (The milkiness will be quite faint if only a little calcium bicarbonate is present.)

Experiment 69.—Many common substances like mortar, most soils, and egg shell contain chalk or calcium carbonate, whilst wood ashes contain potassium carbonate. Try the action of an acid (tartaric acid solution) on these substances in a test tube, and test for carbon dioxide given off in the usual way by holding a drop of lime water in the tube.

Experiment 70.—Many substances like sugar and starch (called "organic" substances) contain the element carbon. You can show this by heating these substances in a small tube, when they will char or blacken as they decompose and leave carbon.

Make a little mixture of sugar and copper oxide, place the mixture in a small tube, and heat. The carbon of the sugar is now given off as carbon dioxide, which you can test for with a drop of lime water as before. Most substances containing carbon will respond to this test.

SODIUM HYDROXIDE OR CAUSTIC SODA
HOW TO MAKE SOAP

Experiment 71.—Sodium hydroxide is one of the most powerful alkalis; you can make a dilute solution of it by stirring up in an old cup some sodium carbonate solution with a little slaked lime. Filter into a clean bottle or tube, and label it.

Feel the solution between your fingers—the liquid has a greasy or "soapy" feel. Test a little of the solution with red litmus or logwood to show that it is an alkali. The sodium hydroxide solution you have made will not be pure—it will contain some unchanged sodium carbonate, but this will not matter in the following, and many other, experiments you may wish to do with it.

Experiment 72.—Add some sodium hydroxide solution to a little dilute copper sulphate solution in a test tube. A blue precipitate of copper hydroxide is formed. Now heat the liquid—the blue precipitate darkens, and slowly turns black. It is now copper oxide (see also Experiment 26).

Experiment 73.—Add sodium hydroxide solution to magnesium sulphate solution. A white precipitate of magnesium hydroxide is formed.

Experiment 74.—Place some sodium hydroxide solution in a porcelain dish, and add a very small piece of fat (lard will do very well). Boil gently for a short time on a stand and gauze, then add a spoonful of salt, and allow to cool. A solid—soap—floats to the top of the liquid. Skim this off, and press it into a little block. The manufacture of soap in this way from various fats and oils is one of the chief uses of sodium hydroxide.

Experiment 75.—Make a solution of alum (the important part of which is aluminium sulphate) in a test tube, and carefully add to it, a few drops at a time, sodium hydroxide solution. A white precipitate consisting of aluminium hydroxide is obtained in the usual way, but now continue adding the sodium hydroxide, when you will find that the precipitate disappears again.

Experiment 76.—Place a small piece of zinc in some of the sodium hydroxide solution in a test tube, and warm gently. Bubbles of gas—hydrogen —are given off. Sodium hydroxide dissolves both zinc and aluminium —this is why washing soda, which forms a little sodium hydroxide when placed in water, should not be used to clean aluminium pans.

Experiment 77.—Place a little of the sodium hydroxide solution in a test tube, and add a short strand of wool. Warm the solution gently, when you will find that the wool dissolves. If you try this experiment with a piece of cotton, you will find that this will not dissolve, and so you have another test to distinguish wool from cotton (see also Experiment 15).

HYDROGEN SULPHIDE—THE "BAD EGG" GAS

Experiment 78.—Place some ferrous sulphide in a test tube, and cover it with a little concentrated tartaric acid solution. Shake up well, and warm gently. A gas is given off with a smell like that of a bad egg—as a matter of fact the same gas is formed when an egg goes bad. Dip a piece of filter paper or blotting paper in a dilute copper sulphate solution, and hold the wet paper at the mouth of the tube. The paper is blackened by the gas.

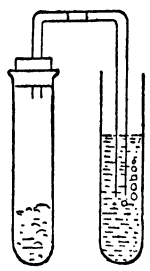


Fig. 10
Making a Solution of Hydrogen Sulphide

Experiment 79.—The name of the gas formed in the previous experiment is hydrogen sulphide. It is soluble in water, and a solution, which is more convenient to handle than the gas, can be made by repeating Experiment 78, but fit the tube with a one-holed cork and delivery tube (Fig. 10), and place the end of the delivery tube in a test tube half full of water. Warm until no more gas is given off, then remove the delivery tube from the water at once.

Experiment 80.—Add a little of the hydrogen sulphide solution to some dilute copper sulphate solution. A black precipitate is formed. This precipitate is copper sulphide, and its formation in this way is the basis of the test for hydrogen sulphide in Experiment 78.

Experiment 81.—Make a little dilute solution of cobalt chloride, and add some of the hydrogen sulphide solution. No precipitate is formed, because cobalt sulphide is soluble in hydrochloric acid which is also formed by this experiment. Now, however, add some ammonia (either household ammonia, or as made in Experiment 88). This neutralises the hydrochloric acid present, and now a black precipitate is formed.

Keep any hydrogen sulphide solution you may have left for future experiments.

SULPHUR DIOXIDE—A BLEACHING GAS

Experiment 82.—Make a solution of sodium bisulphite, and add a little sodium bisulphate. A colourless, sharp-smelling gas called **sulphur dioxide** is given off. The gas, however, is soluble in water, and much of it remains in the solution, forming an acid called **sulphurous acid.** This solution has some very interesting properties, as you will find from the following experiments.

Experiment 83.—Place a coloured flower in some sulphurous acid in a jar, cover with a cardboard lid, and leave for some time. Blue flowers usually work best in this experiment—you should find that the flower is bleached white. Try also with one or two pieces of yellow straw—sulphur dioxide is used particularly for bleaching straw and wool. The solution is also used for preserving fruit—plums, for example, may be bottled in it—the fruit is bleached at the same time.

Experiment 84.—Mix some of the hydrogen sulphide solution previously made with some of the sulphur dioxide solution in a test tube, and allow to stand for some time. If your solutions are strong enough, the liquid should slowly turn milky, owing to the formation of sulphur. The reason is that the hydrogen of the hydrogen sulphide and the oxygen of the sulphur dioxide together form water, and the sulphur from both gases is set free.

SOME EXPERIMENTS ON AMMONIA

Ammonia is a very common substance, to be found in most households: one reason for its presence there was shown by Experiment 66. The following experiments will tell you something about this interesting and important substance. For the experiments where you require ammonia you can use household ammonia diluted with water if you do not get enough of your own manufacture from Experiment 88.

Experiment 85.—Heat a little ammonium chloride (sal-ammoniac) in a dry tube. The white solid does not melt but turns to a vapour which condenses back to white solid further up the tube. This phenomenon is called "sublimation". You may have a small piece of "meta fuel"—used for Primus stoves and for driving toy engines. The substance also sublimates beautifully when heated.

Experiment 86.—Make a little mixture of ammonium chloride and slaked lime on a piece of paper (use about equal quantities of each), and rub the mixture with a rod or pencil. Notice the smell of the ammonia gas given off. Hold a piece of moistened red litmus paper **above** the mixture (do not allow it to touch the mixture). The paper turns blue because ammonia is an alkaline gas—it is in fact the only common alkaline gas.

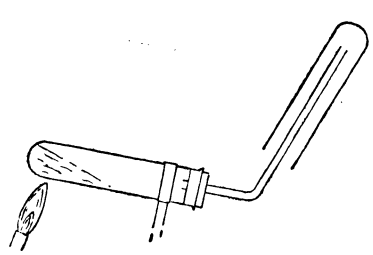


Fig. 11
Collecting Ammonia Gas

Experiment 87.—Collect some ammonia gas by heating some of the mixture of ammonium chloride and slaked lime in a test tube fitted with a one-holed cork carrying a short delivery tube bent at right angles (Fig. 11). Notice that the tube slopes slightly downwards. This is because some water is also formed in the experiment, and holding the tube in the way shown prevents this water running back on to the hot part of the tube. The gas, which is lighter than air, is collected by passing it upwards into another dry test tube.

Experiment 88.—Collect a test tube of ammonia gas as just described, and invert the tube over a small dish of water. Ammonia gas is extremely soluble in water, and as the gas dissolves, water rises rapidly in the tube. The solution formed is properly called ammonium hydroxide, although it is often referred to simply as "ammonia".

Dissolve in this way several tubes of gas in as small a quantity of water as possible, and use the solution for the next experiments.

Experiment 89.—Make a little copper sulphate solution in a test tube, and add a few drops of ammonia solution to it. A blue precipitate of copper hydroxide is formed. Now add more ammonia, the blue precipitate disappears, and a much deeper blue solution than the original is formed. This experiment forms a good method of detecting a copper salt. Try the experiment again, making the copper sulphate solution so dilute that the blue colour is scarcely perceptible. Now add the ammonia, and notice how the blue colour is developed.

Also try Experiment 73 again, using ammonia instead of sodium hydroxide.

Experiment 90.—This experiment will show you how to make a miniature smoke screen. First of all place a little mixture of ammonium chloride and slaked lime in one test tube, and a mixture of sodium chloride (common salt) and sodium bisulphate in another. When this latter mixture is heated a misty gas is given off called **hydrochloric acid gas.** Heat both tubes and hold the mouths of the tubes close together. The two colourless gases given off (ammonia and hydrochloric acid gas) when mixed give rise to a cloud of thick white fumes which consist of solid particles of ammonium chloride.

(End of experiments possible with Outfit No. 2.)

SOME ELECTRO-CHEMICAL EXPERIMENTS

Electricity nowadays plays a very important part in many chemical processes, and that branch of Science in which electricity is used to bring about chemical changes is known as Electro-chemistry. There are several quite simple and most interesting experiments in Electro-chemistry you can carry out with the apparatus and chemicals in the No. 3, 4 and 5 Merit Chemistry Outfits. Many of the experiments illustrate exactly certain industrial processes, such as the way in which caustic soda and sodium hypochlorite are manufactured—both very important substances in everyday life as well as in Chemistry—and how articles are electro-plated.

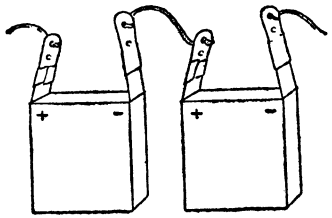


Fig. 12
Batteries Connected in Series

For these experiments, you will require, in addition to the apparatus and chemicals provided, a $4\frac{1}{2}$ volt dry battery, or two ordinary flash light batteries, which are connected together as shown in Fig. 12. Every electric cell or battery has two "poles" or terminals. The short brass strip of a flash light battery is the **positive** terminal, and the long strip the **negative.** Bare the ends of a short length of insulated copper wire, and using the battery clips provided, connect with this wire the positive terminal of one flash light battery to the negative terminal of the other. The batteries are then said to be connected "in series". Use the pair now as one battery, with, of course, a positive and a negative terminal.

Experiment 91.—Bare the ends of two lengths of insulated copper wire, and connect one end of each with battery clips to the terminals of a battery arranged as just described. Connect the other ends of the wires to battery clips, and carefully fit into each of these one of the carbon rods provided, or "electrodes" as they are called. Now dip the electrodes into water in an egg cup or small tumbler. The whole arrangement should be quite clear from Fig. 13.

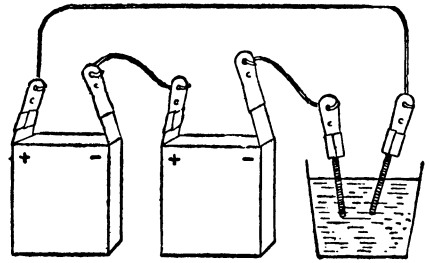


Fig. 13

When you have done this you may be disappointed to find that nothing happens, and there is nothing to be seen, but you have illustrated a very important point—and the experiment is not finished yet. Nothing happens at this stage because pure water is a non-conductor of electricity, and so no current can pass in the circuit as arranged at present.

Now, however, add a spoonful of salt to the water, and stir up. At once you will see gases formed at the electrodes. A current of electricity is now passing, and causing some sort of chemical action. The current also passes if you add sodium sulphate, or ferrous sulphate or any other salt to the water. Substances which added to water make it a conductor of electricity are called **electrolytes.**

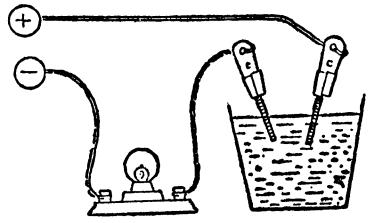


Fig. 14

Experiment 92.—Try the previous experiment again, but instead of salt, add sugar, or starch to the water. Such substances produce no effect—they are not electrolytes. If you have a flash-light bulb and bulb holder, you can insert these into the circuit as shown in Fig. 14, when the effects are more striking. The lamp lights up when the current passes—that is, when there is an electrolyte like salt in the water—but will not light up with sugar in the water.

Experiment 93.—Dissolve a heaped teaspoonful of Glauber's Salt (sodium sulphate) in an egg cup full of water, and place the carbon electrodes, arranged as before, in the liquid. Now fill a test tube with water, put your thumb over the mouth, and invert it in the solution over one of the electrodes—say the one connected to the short or positive terminal of the battery. In this way you can collect the gas given off (Fig. 15). When the tube is half full of gas, put your thumb over the end of the tube, remove it from the liquid, and turn it the right way up. Now place a glowing wood splint in the gas—the wood bursts into flame, showing the gas is oxygen. In the same way collect the gas from the other (the negative) electrode. When the tube is nearly full, remove it as before, and hold the mouth of the tube near a flame. The gas will burn or explode—it is hydrogen. Although it is not easy in an apparatus the size of an egg cup, with a little care you can place both tubes in position at the same time. If you do this, you will find that twice as much hydrogen is formed as oxygen. This process is usually referred to as the electrolysis of water.

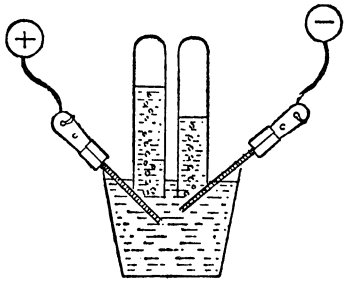


Fig. 15
Collecting the Gases formed during the Electrolysis of Water

Experiment 94.—This experiment, about to be described, is not only one of the most interesting you will have seen, but also illustrates the manufacture of a number of important substances, all at the same time.

Place about two teaspoonsful of salt in an egg cup full of water, and add some litmus solution just coloured red with a drop or two of some acid—vinegar will do. Place your carbon electrodes connected to the battery in the solution, and watch carefully. The liquid round the electrode connected to the positive terminal goes colourless, and the liquid round the other electrode goes blue, showing that there is an alkali being formed. At this electrode also gas is given off. The alkali formed is sodium hydroxide, or caustic soda, which was also made by quite a different method in Experiment 71. The bleaching of the litmus at the positive electrode is caused by the formation of a gas called chlorine. You do not see much of the gas being given off, as it dissolves in water, but you should be able to smell it during the experiment.

In this experiment, therefore, you have made sodium hydroxide, hydrogen (this is the gas formed at the negative electrode), and chlorine, using simply salt water and an electric current.

Experiment 95.—If we want the sodium hydroxide by itself, it is better to arrange so that it is not formed in the same vessel as the chlorine. This can be done by the simple arrangement shown in Fig. 16. Fill two egg cups with strong salt water, and connect the two with a wide strip of

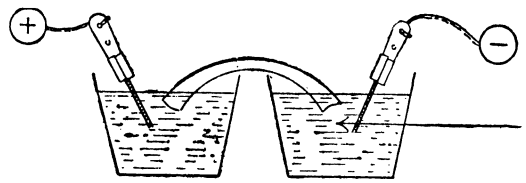


Fig. 16

blotting paper. This will soak up salt solution, and form a connection between the two cups. Place a carbon electrode in each cup. Electrolysis proceeds as before, but the sodium hydroxide is formed in one cup—the one connected to the negative terminal of the battery—and chlorine in the other. Let the current pass for ten minutes or so before stopping the experiment. You can now try Experiments 72 to 77 again, using the sodium hydroxide you have just made by electrolysis. In addition, try the following.

Experiment 96.—Make a dilute solution of cobalt chloride, and add a little sodium hydroxide solution. A blue precipitate of cobalt hydroxide is formed. Now warm, when the blue precipitate will turn pink.

Experiment 97.—Add some sodium hydroxide solution to a dilute solution of ferrous sulphate. In this case a green precipitate of ferrous hydroxide is formed. Put your thumb over the top of the tube, and shake up well for some time. The green precipitate will slowly turn brown as it takes up oxygen from the air and "oxidises" to form ferric hydroxide.

Experiment 98.—If instead of keeping the sodium hydroxide and chlorine formed during the electrolysis of salt solution separate, we allow them to mix, then an entirely new substance is formed. You can make this substance in the following way. Make a strong salt solution in an egg cup as before, and place in the carbon electrodes connected to the battery, but without allowing them to touch, keep them moving about in the liquid, so that the sodium hydroxide and the chlorine formed get thoroughly mixed up. Keep this up for about ten minutes, then stop the experiment. Notice the smell of the solution now—it should remind you of many common household disinfectants and germicides—the well-known product "Milton" is a good example. The solution you have just made contains a most interesting substance called sodium hypochlorite, with which you can do the following experiments.

Experiment 99.—Add a little sodium hypochlorite solution to litmus solution. The colour of the litmus disappears—it is bleached. Try the bleaching effect of the sodium hypochlorite on logwood solution, and on the various fruit juices you have used before—blackberry, blackcurrant, etc. You will find that sodium hypochlorite is an excellent bleaching agent.

Experiment 100.—Write on paper with ordinary ink, allow to dry, and then dab the writing with a pad moistened with sodium hypochlorite. The writing disappears, as the ink is bleached by the hypochlorite. You can therefore use the solution as an ink eraser.

Experiment 101.—Add some acid (e.g. vinegar) to a little of the sodium hypochlorite solution, and very cautiously smell the gas given off. It is chlorine—it has a smell like that of bleaching powder. You may have encountered it before in the swimming bath water; such water is often treated with chlorine, or bleaching powder, to sterilise it.

Experiment 102.—Make a dilute solution of ferrous sulphate, add a crystal or two of sodium bisulphate, and then some sodium hypochlorite. The green colour of the solution turns yellow as the ferrous sulphate is oxidised to ferric sulphate. Now add some ammonia or sodium hydroxide solution. A brown precipitate is formed, of ferric hydroxide.

Experiment 103.—You will probably have in the house some disinfectant of the hypochlorite type, e.g., Milton. Try some of the above experiments with this, and see if you get the same sort of results.

Experiment 104.—Make a salt solution in an egg cup as in previous experiments, and dip into it the copper wires attached to the battery terminals (i.e., remove the clips and carbon electrodes for this experiment). Hydrogen is still formed at the negative electrode, but the chlorine formed at the positive electrode attacks the copper wire, and forms copper chloride, which turns the solution green.

Experiment 105.—You can prove that the solution from the previous experiment does now contain copper by adding ammonia, when you will get a deep blue colour (see Experiment 89).

Experiment 106.—Repeat Experiment 104, but attach the wire connected to the positive terminal to a bright iron nail, and place the nail in the solution. Again the solution goes green, and a green precipitate is formed if you stir the solution up. This precipitate is ferrous hydroxide, formed from the sodium hydroxide produced at the negative electrode, and ferrous chloride formed at the positive electrode.

Experiment 107.—Pour some of the solution and precipitate from the previous experiment into a test tube, and thoroughly shake it up for a few minutes. The green precipitate slowly turns brown, as it slowly takes up oxygen from the air in the test tube, and is oxidised to ferric hydroxide. (See also Experiment 97.)

ELECTRO-PLATING

You copper-plated a piece of iron in Experiment 33 simply by dipping the iron in a solution of copper sulphate. The coating of copper, however, was not very firm, and a better coating of one metal on another than that produced simply by dipping is obtained by electro-plating. You can nickel-plate any small brass or copper object for yourself very well indeed by the following method.

Experiment 108.—It is best to experiment first with a little strip of brass or copper. Thoroughly clean this first of all. Make a solution of nickel ammonium sulphate in an egg cup. Attach the wire from the **negative** terminal of the battery to the brass strip—a battery-clip may be used in this connection. To the wire from the positive terminal attach a carbon electrode as before. Place both carbon electrode and brass object in the solution, and examine the brass from time to time. You will find that it slowly becomes coated with nickel. When the brass is thoroughly covered, remove it, and wash under the tap. Dry it, and polish with some metal polish. You should have a good, bright coating of nickel which will not easily come off.

Experiment 109.—Make a dilute solution of copper sulphate, and add a little sodium bisulphate. Repeat the previous experiment, using this solution, to copper-plate brass.

(It is not possible, using simple materials, to copper-plate iron satisfactorily. The simplest method for iron is the "dipping" process.)

EXPERIMENTS WITH POTASSIUM IODIDE

Potassium iodide is an extremely expensive chemical; the iodide supplied in your Outfit is not pure, but the impurity will not interfere in any way with the following experiments, nor with any others you are likely to want to do with it. You will find it convenient to make about a test tube full of solution (potassium iodide dissolves easily in cold water), and use portions of this solution for the following experiments.

Experiment 110.—To a solution of potassium iodide, add a little sodium bisulphate, and then a little sodium hypochlorite solution, as made in Experiment 98. If you have it, a little hydrogen peroxide will do in place of the hypochlorite. Both of these substances are strong iodising agents,

which liberate iodine from the potassium iodide, and the iodine thus set free turns the solution brown. You now have, therefore, an iodine solution which you should preserve for some of the following experiments (e.g., Experiment 114).

Experiment 111.—For some of the next experiments you will require starch solution. This is made by mixing a little starch with cold water, so as to make a cream. Pour this cream into a cup three-parts full of hot, nearly boiling water. Stir well, and allow to cool.

Experiment 112.—Add a little starch solution to a little iodine solution. An intense blue colour is produced—this forms a delicate test for either starch or iodine. Use this blue solution in the next experiment.

Experiment 113.—Heat some of the blue solution from the previous experiment in a test tube. The blue colour disappears. Now cool the tube by running cold water over it from the tap. The blue colour reappears. The operation can be repeated as often as you like.

Experiment 114.—Add some sodium thiosulphate solution to some of the iodine solution from Experiment 110. The solution becomes colourless. The brown colour can also be discharged from an iodine solution by adding sulphurous acid, as made in Experiment 82.

Experiment 115.—Make a little solution of sodium bisulphite, and add this to some of the blue solution from Experiment 113. Sodium bisulphite also turns the blue solution colourless.

Experiment 116.—Now add some sodium thiosulphate solution to some of the blue solution from Experiment 113. The iodine is removed as in the previous experiment, and so the blue colour vanishes.

Experiment 117.—To a third portion of the blue solution from Experiment 113 add some of your saliva. Put the tube on one side, but examine it from time to time. The blue colour gradually fades, and eventually disappears. This experiment illustrates a very interesting and important fact. The blue colour of the original solution was due to the presence of starch, but substances in saliva—mouth-juices we may call them—convert starch to sugar, which has no effect on iodine, and so the blue colour disappears. This conversion of starch, in such food as bread and potatoes, to sugar, should take place as far as possible in your mouth—hence chew your food before swallowing it!

Experiment 118.—As a result of what has just been said, it will be interesting to show that such substances as bread, potatoes, rice, etc., do contain starch. Heat a little of each of these with water in a test tube, cool the liquid, and add iodine solution, when the blue colour should appear. Remember from Experiment 113 that you will not get the blue colour if the liquid is hot.

Experiment 119.—Make a dilute solution of potassium iodide, add a little starch solution (see Experiment 111) and also a pinch of sodium bisulphate. Write with this mixture, which should be quite colourless. The writing is developed by dabbing with a pad moistened with sodium hypochlorite solution, made yourself in Experiment 98, or in the form of some household disinfectant such as "Milton".

If you have a friend also interested in chemical experiments, it is both instructive and great fun to send each other messages written in one or other of the invisible inks in this booklet, and to find out for yourselves how the messages were written, and how to develop them.

EXPERIMENTS WITH SODIUM THIOSULPHATE

Some experiments have already been described in which use is made of sodium thiosulphate. This substance is commonly called "hypo", and it is used in photography. The following experiment with hypo, if carefully carried out, illustrates beautifully the phenomenon of crystallisation.

Experiment 120.—For this experiment a perfectly clean (preferably an unused) test tube is required. Half fill the tube with hypo crystals, and place the tube in a cupful of hot water. The crystals will melt, and form a colourless liquid. Now remove the tube from the hot water, fix it in a stand, and allow it to cool. If the tube is kept perfectly still, the liquid does not solidify when it cools, as you might expect. Now drop into the cold liquid a tiny fragment of hypo. Crystals immediately begin to form in the liquid, and rapidly spread and grow until in a few minutes the liquid has completely solidified. The spread of the crystals through the liquid is a fascinating process to watch. When crystals form from an ordinary solution, the process takes hours or days, but in this experiment you see the action, as it were, in rapid motion.

Experiment 121.—Make a dilute solution of hypo in a test tube. Add a little tartaric acid solution, and watch carefully. Very slowly the liquid turns milky. This is because the acid sets free sulphur from the hypo; the sulphur, however, does not settle to the bottom of the tube like an ordinary precipitate. It remains suspended in the liquid, making it look like milk.

If this experiment is carried out on a slightly larger scale, say in a glass tumbler, and a lighted lamp then placed behind the milky liquid in the tumbler, the colour of the solution appears to change when examined from different directions, and some interesting "sunset" effects can be observed.

BORAX BEAD TESTS

Experiment 122.—Heat some borax (sodium borate) crystals in a tin tray. The crystals swell up as water of crystallisation is given off. When this action is over, continue to heat a little, then allow to cool, when a clear "glass" of borax should be left. Now add one small crystal of cobalt chloride, melt up again, and allow to cool. The solidified borax is now a beautiful blue colour.

In this way compounds of different metals give different colours with borax. The test is best carried out by making a "bead" of the borax, and using the smallest quantity of the substance to be tested, as in the following experiment.

Experiment 123.—Draw out a glass tube to a point (see Experiment 44). Heat the point, and immediately pick up with it a little borax. Heat this in the flame—the borax swells up as in the previous experiment, and finally forms a clear, glass-like bead. Now carefully pick up with this bead the very tiniest crystal of cobalt chloride, and melt up the bead again. When cool, the bead should have the beautiful cobalt blue colour. Break off this bead, and try the experiment again with copper sulphate instead of cobalt chloride (copper gives a green bead), with ferrous sulphate (iron compounds give a green or yellow bead), and nickel ammonium sulphate (brown bead due to the nickel).

Experiment 124.—Make a dilute solution of borax, and try for yourself some "double decomposition" experiments with this solution and solutions of copper sulphate, cobalt chloride, nickel ammonium sulphate, and alum.

NICKEL AMMONIUM SULPHATE

This compound is an interesting example of what is called a "double salt"—it contains both nickel sulphate and ammonium sulphate, and yet it is not just a mixture of these two.

Experiment 125.—Make a mixture of a little nickel ammonium sulphate and slaked lime, place the mixture in a small tube, and heat. Notice the smell of ammonia given off; you can also test for this by holding a piece of moist red litmus paper at the mouth of the tube—the paper is turned blue.

Experiment 126.—Make a little dilute nickel ammonium sulphate solution in a test tube, and add some hydrogen sulphide water as made in Experiment 79. No change should be seen. Now add some ammonia. A black precipitate of nickel sulphide is formed. In this way nickel behaves like cobalt in Experiment 81.

Experiment 127.—What colour is nickel hydroxide? You can find out by adding sodium hydroxide solution to nickel ammonium sulphate, and then examining the precipitate.

SOME PECULIAR PROPERTIES OF CHARCOAL

Experiment 128.—Shake up some hydrogen sulphide water (Experiment 79) with charcoal in a test tube, or better in a corked bottle. After some time the smell of the hydrogen sulphide should disappear almost entirely from the solution. Charcoal, especially certain forms of it, absorbs gases very readily—this is the reason for its use in gas masks.

Experiment 129.—Charcoal not only absorbs gases, but also many coloured substances from solution. Warm some litmus solution with a little charcoal for some time, then filter. The liquid will now be much paler than the original solution—perhaps quite colourless if you have not made the original solution too strong.

Experiment 130.—Repeat the previous experiment with logwood solution, ink diluted with water, and other coloured solutions.

Experiment 131.—Make some wood charcoal by heating small pieces of wood in a tube—or you may have some from Experiment 39, and try the previous experiments (128–130) with this. You should obtain similar though perhaps not quite so good results. As already pointed out, some forms of charcoal give better results than others in this work.

The experiments in this booklet, as was pointed out in the Introduction, are but a few of the many which may be carried out with your Set. Even in the simplest experiments, tried perhaps hundreds of times before, there may be something that has not previously been observed, so that scientific experiments of every kind are of never-ending interest. If you require any help with your experiments; if you think you have an original experiment worthy of notice, or if you are keen on your hobby and would like an explanation of something you do not understand, do not hesitate to ask your Chemistry Master who will do his best to help you.

CHEMISTRY APPARATUS AND ACCESSORIES

†810. Absorption Tube. 'U' Form 4″ × ½″ lipped
808. Asbestos Square, 5¼″ × 5¼″
†811. Beaker, Glass, 50 ml.
†809. Beehive Shelf
†826. Blow Pipe, 7″
827. Bottle, Glass, with cap, 2 ozs.
868. Bottle, Polythene, with cap, 4 ozs.
†800B. Bunsen Burner (see notes below)
†869. Bunsen Burner, Flame Spreader
†872. Burette with Tap, 10 ml.
812. Carbon Rod, 1″ × ¼″
873. Charcoal Block, 2″ × 1¼″ × 1¼″
†874. Chemical Balance
875. Chemical Balance, Set of Weights (m.g.)
†813. Crucible, 15 ml.
†814. Crucible Lid
†815. Crucible Tongs, 6½″
†876. Deflagrating Spoon and Cap
†877. Delivery Tube
†817. Dropping Pipette with rubber teat
818. Evaporating Basin, 42 ml.
797. Filter Papers, 3″ (Packet of 12 papers)
821. Filter Papers, 3″ (Packet of 100 papers)
†878. Flask, Conical (Heat Resistant), 100 c.c.
†822. Flask, Flat Bottom, 50 c.c.
†879. Flask, Flat Bottom (Heat Resistant), 100 c.c.
†819. Funnel, Filter, Glass, 2″
820. Funnel, Plastic
†837. Funnel, Thistle, 12″
†880. Gas Jar, 6″ × 2″, with lid
*824. Glass Tubing ¼″ O.D., nom. 3″ lengths
*825. Glass Tubing ¼″ O.D., nom. 12″ lengths
*796. Glass Tubing ⅛″ O.D., nom. 12″ lengths
871. Instruction Book No. 0 (for Outfits Nos. 0 and OA only)
828. Instruction Book No. 1–5
829B. Litmus Paper, Blue (Book of 20 sheets)
829R. Litmus Paper, Red (Book of 20 sheets)

881. Magnesium Ribbon
†882. Measuring Cylinder, 100 ml., graduated
†883. Measuring Glass, 2 ozs., graduated
†830. Measuring Pipette, 10 ml., graduated
†884. Pestle and Mortar, complete
†885. Pipeclay Triangle, 2″
†886. Retort, Glass, 125 c.c. with tubulure and cork
†887. Retort Clamp with boss
†888. Retort Stand with two rings
831. Rubber Tubing, 17/32″; I.D., 6 ft. length, (fits 800B and 796)
794. Rubber Tubing, 5/32″; I.D., 3 ft. length, (fits 824 and 825)
889. Saws, Glass-Cutting (3 per packet)
795. Scoop, Polythene
*798. Stoppers, Cork, ½″ (fits 833 and 834)
*816. Stoppers, Cork, ½″, with hole (fits 833 and 834)
*890. Stoppers, Cork (fits 835 and 878)
*891. Stoppers, Rubber (fits 833 and 834)
†799. Spirit Burner, Glass, complete with wick
840. Spout Brush
*833. Test Tubes, 3½″ × ½″
*834. Test Tubes, 4″ × ½″
*835. Test Tubes, 5″ × ¾″
892. Test Tubes, 6″ × 1″ (Heat Resistant)
836. Test Tube Holder, metal
†893. Test Tube Holder, wood
894. Test Tube Stand, plastic
†895. Test Tube Stand, wood
896. Thermometer, Centigrade, —10° to 110°
897. Thermometer, Fahrenheit, 0° to 240°
898. Thermometer Tube, Unsealed
†838. Tripod
839. Watch Glass
†841. Wire Gauze, 4″ × 4″
899. Wire Gauze, 5″ × 5″, with Asbestos Centre

† Illustrated overleaf. * Minimum 1 doz.

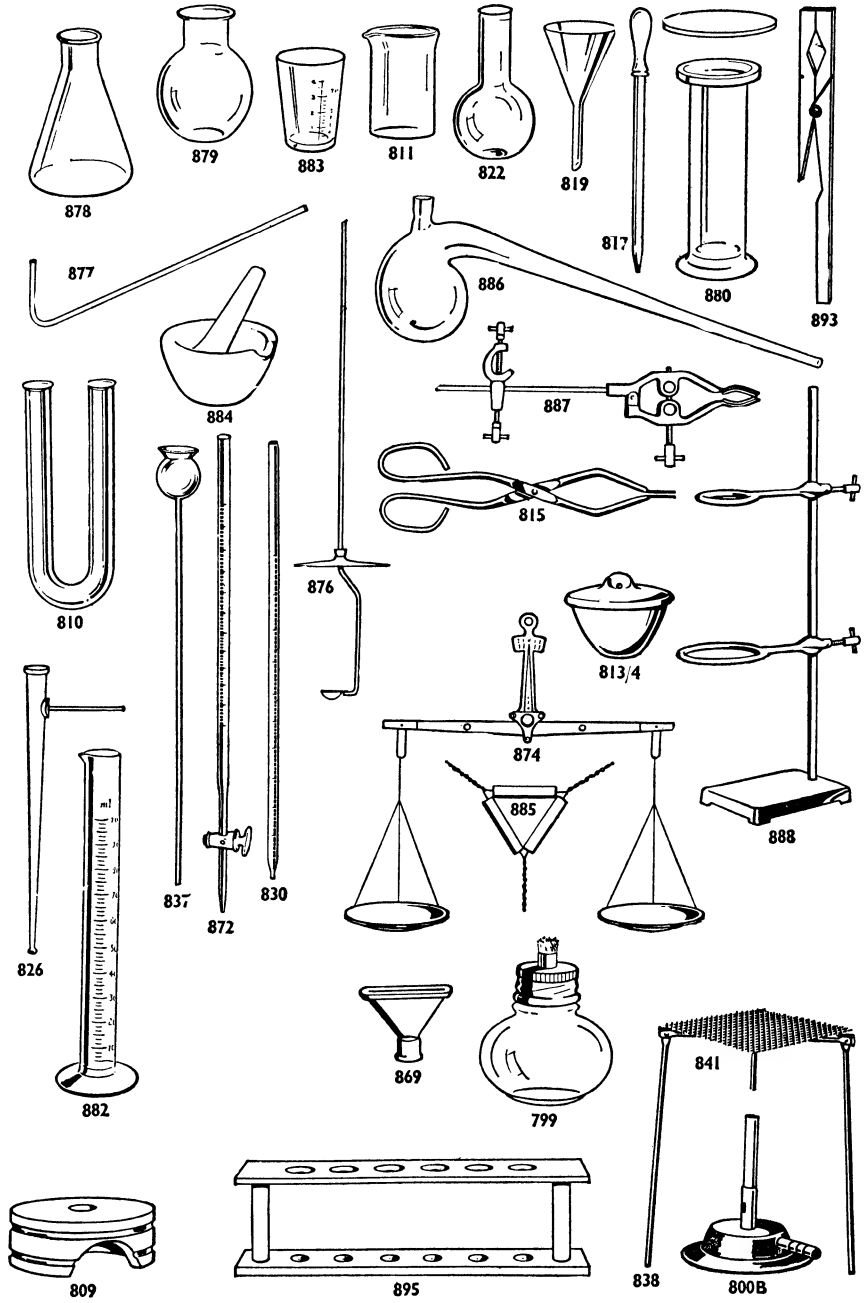
CHEMICALS

842. Alum
843. Ammonium Chloride
844. Charcoal Decolourising
845. Cobalt Chloride
846. Copper Oxide
847. Copper Sulphate
848. Ferrous Sulphate
849. Granulated Zinc
850. Iron Filings
851. Iron (Ferrous) Sulphide
852. Litmus Powder
853. Logwood
854. Magnesium Sulphate
855. Manganese Sulphate
856. Marble Chips (Calcium Carbonate)
857. Nickel Ammonium Sulphate
858. Potassium Iodide
859. Slaked Lime (Calcium Hydroxide)
860. Sodium Bisulphate
861. Sodium Bisulphite
862. Sodium Borate
863. Sodium Carbonate
864. Sodium Chloride
865. Sodium Sulphate
866. Sodium Thiosulphate
867. Tartaric Acid

IMPORTANT: The Bunsen Burner is suitable for use with coal gas only and should not be used with natural or methane gas.

The above mentioned apparatus and accessories can be obtained from your local "MERIT" Chemistry Outfit Stockist or if you have any difficulty in obtaining them locally please write direct to:

J. & L. Randall Ltd., Potters Bar, Herts., asking for a current price list and order form.



CHEMISTRY

INSTRUKSIEBOEK

S. R. STUBBS, M.Sc., A.R.I.C.

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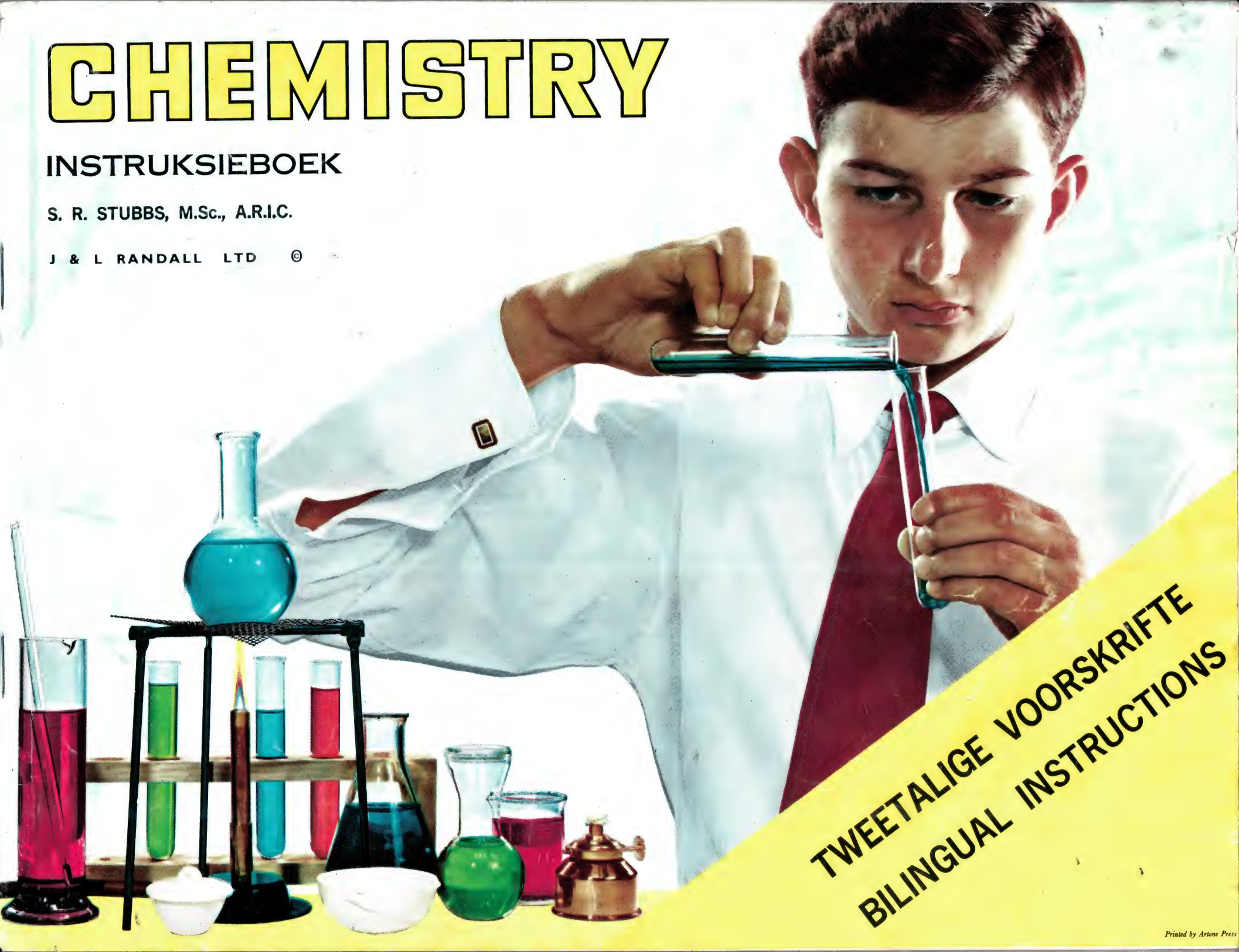


TWEETALIGE VOORSKRIFTE
BILINGUAL INSTRUCTIONS

Printed by Artone Press

MERIT

CHEMISTRY

Instruksieboek vir Chemistelle Nos. 1A, 2, 3

VOORWOORD

Die doel van die MERIT Chemiestelle is om 'n aangrypende stokperdjie ook leersaam te maak, en die eksperimente is met dié doel voor oë gekeur. HULLE is ook GEKEUR VIR VEILIGHEID. 'n Glanspunt van die Merit stelle is die **afwesigheid van gevaarlike stowwe**, al die voorgeskrewe eksperimente kan dus sonder enige risiko gedoen word. 'n Verdere puntjie wat dikwels uit die oog verloor word is dat **geen kombinasie van enige van die stowwe in die stel kan 'n gevaarlike eksperiment tot stand bring nie**. Daarom kan die gebruiker na eie goeddunke eksperimenteer en sodoende die maksimum waarde uit die stel put sonder enige nadelige gevolge.

INLEIDING

Die mens is van nature 'n nuuskierige wese. Dit is dus nie verbasend nie dat hy aansienlik aandag sal wy aan die studie van die talryke grondstowwe in die natuur – grondstowwe wat voedsel en klerasie kan verskaf, metale vir nuts- of sierdoeleindes, geneesmiddels vir kwale, ensovoorts. Hierdie bestudering van stowwe is chemie. Deur die eeue heen is daar betreklik min ontdekkingswerk in dié vakgebied gedoen. Die ontdekkings van die afgelope 100 jaar is egter ongelooflik talryk. Die mens was in sy ontdekkingsywer nie tevrede met natuurlike grondstowwe nie, hy het, deur sy kennis van die chemie te vergroot, die grondstowwe veredel en in die laboratoriums selfs nuwe stowwe ontdek – stowwe wat in die natuur onbekend is. Dié ontdekkings het vir ons nuwe en beter verdowingsmiddels, nuwe kleurstowwe, nuwe legerings vir die ingenieursbedryf besorg, nuwe stowwe vir klerasie – die lys kan boekdele beslaan. Dit is dus geen wonder dat die skeikundige soveel belang het by sy werk nie, want die skeikunde is net so boeiend as enige spel, en dit kan 'n stokperdjie word wat eindelose genot verskaf. Die beste wyse waarop skeikunde bestudeer kan word is deur eksperimentering, en die voordeligste eksperimente is die wat jy self doen. Jy sal in die eenvoudigste eksperiment wat jy self doen die genot van 'n ware ontdekking beleef. Voor jy egter begin, lees die aanwysings noukeurig deur. Dit sal meebring dat jou eksperimente slaag en ook help om die volle waarde uit jou MERIT-stel te put.

Eksperimente 1 – 39 kan gedoen word met stel No. 1A
Eksperimente 1 – 90 kan gedoen word met stel No. 2
Eksperimente 1 – 131 kan gedoen word met stel No. 3

1. Hou jou hande skoon en so ook die tafel of blad waarop jy werk. Hou 'n lap byderhand sodat jy dadelik enige vloeistof wat miskien stort kan opvee. Die kombuis, garage of solder is gewoonlik die aangewese plek om te werk.

2. Tensy daar ander voorskrifte is, is dit wenslik om klein hoeveelhede te gebruik, maak oplossings flou of „verdun" aan, dit is nie net meer ekonomies nie maar lewer ook gewoonlik beter resultate.

3. Hou 'n aantekeningboek byderhand en teken elke eksperiment aan met die resultate én wat jy waargeneem het. Net soos 'n fotograaf of seëlversamelaar genot put uit 'n album, so is dié notaboek 'n bron van genot vir die skeikundige. Dit het ook waarde wanneer jy wil weet wat by 'n vorige geleentheid plaasgevind het, voordat jy 'n eksperiment aanpak.

4. Hou die proefbuis met die draadtangetjie vas wanneer jy iets daarin warm maak. Indien jy 'n vastestof-en-vloeistofmengsel wil warm maak gooi eers die vloeistof in die buis en dan die vaste stof. Dit verhoed dat die vaste stof neerslaan of saampak onder in die buis. Maak die onderent van die proefbuis geleidelik warm, en laastens, moet nooit die bek van die proefbuis na jouself of enigiemand anders toe draai nie.

5. Gebruik die skoppie vir al die chemikalieë, **nie** vingers nie. Waar daar in die voorskrifte gepraat word van 'n „klein hoeveelheid" of „'n bietjie" sal 'n halwe skeppie gewoonlik heeltemaal voldoende wees. Plaas alle ongebruikte chemikalieë dadelik weer terug in die betrokke houertjie. Maak die apparaat deeglik skoon voor jy dit bêre.

6. Moenie aan die chemikalieë proe nie want sommige is giftig. Hou ook die chemikalieë weg van klein kinders af.

7. Wanneer jy iets warm maak in 'n buis of enige ander glashouer, doen dit geleidelik om te verhoed dat die glas bars. Aanvanklik moet die houer net vir 'n oomblik in die vlam geplaas word en dan weggeneem word, dan weer teruggeplaas word en weer weg sodat dit geleidelik warm word. Begin ook eers in die koelste deel van die vlam en gaan dan gaandeweg na die warmste deel van die vlam.

DIE SPIRITUSBRANDER

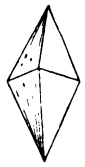
'n Merit-spiritusbrander word verskaf met party van die stelle (kyk bl. 1). Om die brander vol te maak, skroef die pithouer af,

maak dit vol BRANDSPIRITUS, skroef die pithouer weer styf vas en droog die brander af. Verstel die pit sodat ongeveer 3 mm (1/8") uitsteek. Dit sal 'n vlam gee wat aan alle vereistes sal voldoen. Indien jy die vlam wil verstel terwyl die vlam brand, gebruik 'n doringtangetjie. Veiligheidshalwe is dit raadsaam om seker te maak dat die spiritusvoorraadbottel styf toe en weggebêre is voordat jy die brander opsteek.

HOE OM KRISTALLE TE MAAK

Die maak en bestudering van kristalle is een van die aangrypendste fasette van skeikunde. Kristalle kom voor in allerhande vorms en kleure. In die natuur kan hulle gevind word tussen rotse of in die growwe sand van 'n rivierbedding of langs die see. Die volgende eksperimente sal jou leer om 'n paar self te „kweek".

Eksperiment 1.—Gooi ongeveer 25 mm. (1 dm) water in 'n proefbuis. Voeg 'n bietjie kopersulfaat by. Verhit stadig tot dit louwarm is en die kopersulfaat oplos. Voeg nog 'n bietjie kopersulfaat by. Hou so aan totdat die laaste bietjie nie meer oplos nie of baie stadig oplos. Skud die proefbuis gedurig liggies. Die oplossing is nou versadig. Gooi die helder vloeistof versigtig uit in 'n horlosieglas en laat dit afkoel sonder dat dit aangeraak word. Daar sal redelik gou klein blou diamantvormige kristalletjies gevorm word. Bekyk hulle deur 'n vergrootglas. Gooi die vloeistof af en sit die kristalle op 'n stukkie kladpapier om droog te word. Indien jy hulle nie wil bêre nie sit hulle terug in die houer saam met die ander voorraad.



Afb. 1
Aluin kristal

Eksperiment 2.—Dieselfde as eksperiment No. 1, maar gebruik aluin i.p.v. kopersulfaat.

Doen die eksperiment weer; maar gebruik dié keer magnesiumsulfaat.

Eksperiment 3.—As jy 'n mikroskoop het (die Merit mikroskope is ideaal vir algemene gebruik), bekyk 'n paar druppels van die warm versadigde kopersulfaat-, magnesiumsulfaat-, of aluinoplossing om te sien hoe die kristalle vorm.

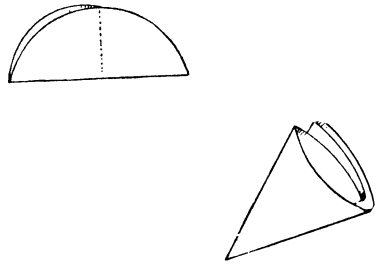
Eksperiment 4.—Hoe om 'n groot kristal te „kweek." Maak omtrent 'n halwe proefbuisvol versadigde aluinoplossing. Gooi dit in 'n eierkelkie of 'n klein glasie. As die oplossing nie helder is nie moet dit gefiltreer word (kyk Eksperiment No. 7). Kies nou 'n mooi groot kristal uit dié van eksperiment 2, en sit dit in die oplossing. Los in 'n koel plek en draai die kristal om sodat dit elke dag op 'n ander vlak lê. Dit behoort 'n betreklike groot kristal te kweek, soos in afbeelding I.

Eksperiment 5.—Sit 'n bietjie kopersulfaat in een van die buise wat jy gewoonlik gebruik om vaste stowwe in warm te maak. Hou die proefbuis vas met die tangetjie en maak dit liggies warm. Stoom sal afgeskei word – die kopersulfaat bevat 'n sekere hoeveelheid water wat bekend is as „kristalisasiewater". Die blou kristalle sal wit word. Laat die buis en sy inhoud heeltemaal koud word en voeg dan een of twee druppels water by die wit kopersulfaat. Dit sal weer blou word.

Eksperiment 6.—Doen die vorige eksperiment maar gebruik dié keer kobaltchloried. In hierdie eksperiment word die pienk stof blou wanneer die kristalisasie water verdamp. Dit verduidelik hoekom kobaltchloried as 'n simpatetiese ink gebruik word in eksperiment 35. Alle kristalle bevat nie kristalisasiewater nie.

Probeer nou self om uit te vind of sout en aluin dit bevat of nie.

SURE, ALKALI'S EN INDIKATORS



Afb. 2
Hoe om filtreerpapier te vou

Eksperiment 7.—Maak 'n proefbuis half vol water, voeg 'n bietjie lakmoespoeier by, en maak die oplossing warm. Vou 'n filtreerpapier (soos in die afbeelding) en sit dit in 'n tregter. Gooi nou die lakmoesoplossing in die papier en vang dit op in 'n skoon proefbuis. Die helder, pers oplossing kan dikwels gebruik word in latere eksperimente. Klein medisynebotteltjies is nuttig om vloeistowwe in te bêre.

Eksperiment 8.—Herhaal die vorige eksperiment met campêchehout (bloedhout) en bêre ook dié oplossing. Dit sal ook by 'n latere geleentheid gebruik word.

Eksperiment 9.—Maak 'n flou wynsteensuuroplossing en gooi 'n paar druppels in 'n bietjie lakmoesoplossing. Blou of pers lakmoes verkleur na rooi. Die kleurverandering word in eksperiment 13 uiteengesit.

Eksperiment 10.—Voeg ook asyn, suurlemoensap en ander vrugtesappe by lakmoesoplossings en kyk wat gebeur. Asyn bevat 'n suur wat bekend staan as asynsuur en suurlemoene bevat sitroensuur.

Eksperiment 11.–Maak 'n lakmoesoplossing rooi deur een druppel asyn by te voeg. Gooi 'n bietjie van die oplossing oor in 'n ander proefbuis en voeg 'n bietjie gebluste kalk (kalsiumhidroksied) by. Die lakmoes sal nou weer blou word. 'n Stof soos gebluste kalk wat rooi lakmoes na blou laat verkleur word 'n alkali genoem.

Eksperiment 12.–Jy het seker beide ammoniak en wassoda in die huis. Kyk wat die stowwe aan lakmoes doen. Albei is alkali's.

Eksperiment 13.–Toets die sure en alkali's genoem in eksperimente 9 tot 12 met 'n campêchehoutoplossing. Suur sal die oplossing geel kleur en alkali's sal dit blou kleur. Stowwe soos lakmoes en campêchehout wat verkleur na die suur- of alkali-aard van 'n stof, word **indikators** genoem. Die gekleurde sap van verskeie vrugte, plante en bessies is indikators, Probeer framboos- en swartbessiesap, braam, vlierbessie en beet met alkali's en sure. ('n Maklike manier om party van die vrugtesappe te kry is om 'n teelepel vrugtekonfyt in water op te los en dan te filtreer sodat jy 'n helder gekleurde vloeistof het.

Eksperiment 14.–Dit is dikwels gerieflíker om lakmoespapier te gebruik. Week filtreerpapier of kladpapier in 'n lakmoesoplossing. Laat dit droog word en sny dan in smal strokies. Maak sowel blou as rooi lakmoespapier. Die rooi papier kan gemaak word deur die rooi lakmoesoplossing van eksperiment 11 te gebruik. Daar is ook lakmoespapier in die stel.

HOE OM EGTE EN KUNSSY TE ONDERSKEI

Eksperiment 15.–Verhit 'n klein stukkie egte sy in 'n proefbuis en hou 'n stukkie nat rooi lakmoespapier in die bek van die proefbuis. Die papier word blou as gevolg van die ammoniak, 'n alkaliese gas, wat afgeskei word. Probeer nou die eksperiment met kunssy en gebruik dié keer blou lakmoespapier. In dié geval word suurdampe afgeskei en die papier word rooi. Die rede vir die verskynsel is dat diervesels soos wol en sy stikstof bevat (dit is ook een van die gasse in lug), en wanneer die stowwe verhit word, word ammoniakgas, wat ook stikstof bevat, afgeskei. Eweneens bevat katoen en kunssy (wat van katoen gemaak is) geen stikstof nie omdat hulle plantaardig is, en daarom word 'n suurdamp afgeskei.

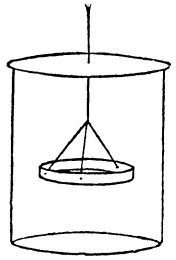
Eksperiment 16.–Probeer eksperiment 15 met wol, katoen, linne, tou en leer en kyk of jy kan vasstel watter moontlik plantaardig is en watter van diere afkomstig is.

EKSPERIMENTE MET SUURSTOF

Die belangrikheid van suurstof in die lug is alombekend. Sonder suurstof kan niks lewe nie. Met elke asemtog word ons longe gevul met lug en sodoende ook suurstof wat dan deur die bloed na die verskeie liggaamsdele vervoer word, waar dit afvalstowwe verbrand en koolstofdioksied vorm wat dan weer uitgeasem word. Vliegtuigloodse wat in die verdunde lug hoog bokant die aarde vlieg neem hul suurstofvoorraad saam met hulle. Hospitaalpasiënte wat aan longaandoenings ly, kry ook suurstof. Net soos suurstof by asemhaling nodig is, so ook vergemaklik dit verbranding. Dit veroorsaak hewiger verbranding as lug en het daarom ook aanleiding gegee tot die ontwerp van die oksiasetileensweispyp.

Dit is moontlik om suurstof te maak van stowwe wat in die meeste huise te vinde is – waterstofperoksiedoplossing, en die bleik- en ontsmetoplossing van hipochloriet (bv. Milton, Jik). Indien een of albei van die oplossings nie beskikbaar is nie blaai dan na eksperiment 29 waar jy 'n plaasvervanger sal kry wat vir ons doel net so doeltreffend is.

Eksperiment 17.–Voor jy begin met die eksperiment kry 'n houtstokkie. ('n Vuurhoutjie sal nie deug nie want die hout is in 'n oplossing deurweek, wat verhoed dat dit gloei na die vlam doodgeblaas is.) Gooi 'n bietjie waterstofperoksiedoplossing in 'n proefbuis en voeg 'n paar druppels hipochlorietoplossing by. Die mengsel sal kwaai bruis en suurstof afskei. Steek die stokkie dadelik aan die brand en blaas die vlam dan dood. Druk nou die gloeiende end van die stokkie by die bek van die proefbuis in en kyk hoe dit dadelik weer aan die brand slaan en helder brand in die suurstof.

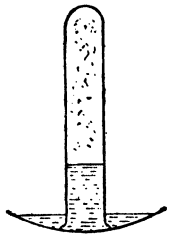


Afb. 3

Eksperiment 18.–Maak drie gaatjies in 'n blik dekseltjie en hang dit aan 'n draadjie soos in Afb. 3. Plaas 'n stukkie kers regop op die dekseltjie en steek dit aan die brand. Die draadjie waaraan die deksel en kers hang moet deur 'n stuk karton gedruk wees sodat die karton 'n deksel kan vorm vir 'n konfytfles. Gooi 'n bietjie waterstofperoksiedoplossing in 'n konfytfles en voeg 'n paar druppels hipochlorietoplossing by. Die fles sal nou met suurstof vul. Laat sak nou die kersie in die suurstof in en kyk hoe helder dit brand.

Eksperiment 19.–Vir dié eksperiment is die dekseltjie nie meer nodig nie, maar gebruik weer die stuk karton soos in die vorige eksperiment. Vul weer 'n konfytfles met suurstof soos in die vorige eksperiment. Vat 'n stukkie draad met 'n tang en maak die ent rooiwarm. Druk nou die draadjie vinnig in die fles en kyk hoe dit vonk. Self 'n metaal soos yster brand in suurstof!

HOE OM DIE HOEVEELHEID SUURSTOF IN DIE LUG TE BEPAAL



Afb. 4
Yster roes in 'n proefbuis

Eksperiment 20.–Maak die binnekant van 'n proefbuis goed nat en gooi 'n paar ystervylsels in die buis sodat hulle aan die kante kleef. Sit die proefbuis nou onderstebo neer in 'n piering water en laat dit vir 'n paar dae so staan. (Afb. 4)

Sodra die yster begin roes styg die watervlak in die buis op.

Die yster kombineer met die suurstof in die lug om te roes. Namate die suurstof opgebruik word styg die water in die proefbuis. Die water sal omtrent een vyfde van die buis se lengte opstyg. Die gedeelte is die hoeveelheid suurstof in die lug. Net soos yster suurstof vereis om te brand of om te roes, so ook moet mense en diere ens., ook suurstof hê om te kan asemhaal. Die twee prosesse het nogal 'n redelike sterk ooreenkoms met mekaar. Vir die volgende paar eksperimente moet jy kalkwater hê, en dit word soos volg berei.

Eksperiment 21.–Gooi 'n klompie gebluste kalk in 'n flesvol water. Skud goed. Filtreer die mengsel en plak 'n etiket op. Die wit poeier wat op die filtreerpapier is kan nou in die leë fles teruggesit word en weer met water gemeng word om sodoende nog kalkwater te maak. Dit word dan weer gefiltreer.

Eksperiment 22.–Plaas 'n stukkie kers op die blik dekseltjie soos in eksperiment 18. Steek die kersie aan die brand en laat dit sak in 'n konfytfles. Sodra die vlam doodgaan, trek die kers uit en gooi 'n bietjie kalkwater in die fles. Skud goed. Die kalkwater sal nou wit word as gevolg van die koolstofdioksiedgas. Hierdie gas is gevorm deur die kersvet wat met die suurstof in die lug kombineer terwyl die kers brand.

Eksperiment 23.–Gooi 'n bietjie kalkwater in 'n horlosieglas en laat dit vir 'n dag of wat staan. Die kalkwater sal nou ook wit word. Daar is dus in die lug ook koolstofdioksied. Die wit in die kalkwater word veroorsaak deur die koolstofdioksied wat met die gebluste kalk (kalsiumhidroksied) in die water verbind en kalsiumkarbonaat (kryt) vorm. Dié onoplosbare stof maak dan die vloeistof wit.

Eksperiment 24.–Maak 'n proefbuis omtrent 'n derde vol kalkwater en blaas dan deur 'n glaspypie in die oplossing. (Die pypie wat vir die doel gebruik word moet skoon wees en die kante gladgemaak deur dit in 'n vlammetjie te hou tot die glas sag word.) Die kalkwater word weer wit as gevolg van die koolstofdioksied wat jy uitasem. Die lug wat jy inasem bevat suurstof wat in die liggaam met koolstof verbind en koolstofdioksied vorm wat dan uitgeasem word – 'n proses wat baie na verwant is aan die verbranding van die kers in eksperiment 22.

OMSKAKELING VAN VERBINDINGS

Jy sal al opgelet het dat verbindings, net soos mense, 'n voornaam en 'n van het. Wanneer die verbindings vermeng word in 'n oplossing dan skakel hulle dikwels om en maak nuwe verbindings. Dit is amper soos twee seuntjies Koos Human en Piet van der Merwe wat baklei en so deurmekaar raak dat hulle uiteindelik twee nuwe seuntjies is:

Koos Human + Piet van der Merwe

= Koos van der Merwe + Piet Human.

Die volgende eksperimente illustreer die omskakeling.

Eksperiment 25.–Maak 'n oplossing van kopersulfaat in 'n proefbuis, en voeg 'n bietjie kalsiumhidroksied (kalkwater) by. Twee nuwe verbindings word nou gevorm koperhidroksied en kalsiumsulfaat.

Kopersulfaat + kalsiumhidroksied

= koperhidroksied + kalsiumsulfaat.

Die koperhidroksied is egter nie-oplosbaar en kan dus nie in die oplossing bly nie – dit verskyn as 'n blou neerslag of presipitaat.

As twee oplossings gemeng word en 'n nie-oplosbare vaste stof word gevorm deur die omskakelingsproses, dan sal die stof gewoonlik neerslaan.

Eksperiment 26.–Gaan 'n stappie verder met die vorige eksperiment deur die vloeistof met die blou koperhidroksied te kook. Die neerslag sal gaandeweg verdonker totdat dit swart is. Dit is nou koperoksied. (As die eksperiment nie heeltemal slaag nie is dit omdat daar nie genoeg kalkwater in die oplossing is nie. Probeer weer maar gebruik minder kopersulfaat en meer kalkwater.)

Eksperiment 27.–Die omskakelingsproses (skeikundig bekend as dubbelontbinding) word met die volgende pragtige eksperiment geïlustreer. Maak 'n aluinoplossing (aluminiumsulfaat) in 'n proefbuis en voeg kalkwater by. Aluminiumhidroksied verskyn as 'n vae wit neerslag. Kyk baie goed na die mengsel om die neerslag raak te sien. Voeg nou 'n bietjie lakmoesoplossing by, maak die proefbuis versigtig warm en laat dit dan afkoel. Die neerslag neem 'n deel van die lakmoes op en wys dan as 'n lieflike blou neerslag.

Eksperiment 28.–Probeer nou 'n dubbelontbindingseksperiment met kalkwater en 'n kobaltchloriedoplossing en kyk watter kleur is kobalthidroksied.

Eksperiment 29.–Herhaal eksperiment 28 maar gebruik mangaansulfaat in plaas van kobaltchloried. Die keer word 'n vleeskleurige mangaanhidroksied neerslag gevorm. Gooi nou 'n bietjie waterstofperoksiedoplossing in 'n skoon proefbuis. Skud die buis met die vloeistof en neerslag in goed en voeg 'n bietjie daarvan by die waterstofperoksiedoplossing. Die vleeskleurige neerslag word nou

swart terwyl die hele mengsel kook en suurstof afskei. Die eksperiment wys hoe suurstof gemaak kan word met 'n mangaanhidroksiedoplossing in plaas van die hipoclorietoplossing in eksperiment 18.

Eksperiment 30.—Die interessantste dubbelontbindingseksperimente kan gedoen word met die stowwe in die stel en 'n maklik verkrygbare stof bekend as „waterglas". Dié stroopagtige stof word gewoonlik gebruik om eiers te bewaar en is skeikundig bekend as **natriumsilikaat.**

Los 'n eetlepel waterglas op in 'n koppie warm water en laat dit afkoel. Gooi 'n bietjie van die oplossing in 'n proefbuis en voeg 'n bietjie magnesiumsulfaatoplossing by. 'n Wit magnesiumsilikaat neerslag word gevorm. Probeer dieselfde eksperiment met kopersulfaat-, mangaansulfaat- en kobaltchloriedoplossings. Die stowwe vorm lieflike gekleurde kopersilikaat-, mangaansilikaat- en kobaltsilikaatpresipitate.

Eksperiment 31.—Die chemiese tuin. Gebruik die res van die waterglasoplossing wat jy vir eksperiment 30 gemaak het om hierdie kleurvolle eksperiment te doen. Gooi die oplossing in 'n glas en gooi dan 'n paar stukkies kopersulfaat, mangaansulfaat, magnesiumsulfaat, aluin en kobaltchloried, so groot soos 'n speld se kop, daarin en kyk wat gebeur.

Na 'n paar minute, sal draadjies op die magnesiumsulfaat en aluin verskyn. Die gekleurde uitgroeisels op die ander stowwe sal 'n rukkie langer neem om te verskyn. Na 'n ruk sal die draadjies begin vertak totdat daar, na 'n dag of wat, 'n veelkleurige onderwatertoneeltjie gevorm is. Die „groeisels" is die nie-oplosbare gekleurde metaalsilikate. Die verskynsel verklaar die naam „chemiese tuin", wat aan die eksperiment gegee is.

Eksperiment 32.—Maak 'n flou kopersulfaatoplossing in 'n proefbuis en voeg 'n paar ystervylsels by. In dié eksperiment skakel die yster om met die koper in die oplossing. Die oplossing sal ligter en ligter word, terwyl die koper die plek van die yster in neem onder in die proefbuis. (Die vaste stof onder in die proefbuis mag miskien nie soos koper lyk nie want dit is baie fyn en kan dus byna swart voorkom.)

Eksperiment 33.—Maak 'n flou kopersulfaatoplossing en doop 'n stukkie blink yster of 'n knipmeslem vir 'n paar oomblikke daarin. Dieselfde reaksie as in eksperiment 32 vind plaas maar die keer vorm die koper 'n laag op die yster. Die oplaag is egter nie baie vas nie en kan maklik afgepoleer word.

SIMPATETIESE INK EN GEHEIME SKRIF

Eksperiment 34.—Maak 'n flou kopersulfaatoplossing en skryf daarmee op 'n vel papier. Wanneer dit droog geword het behoort die skrif onsigbaar te wees, maar dit kan weer sigbaar gemaak word (ontwikkel word) deur die papier óf naby 'n vlam warm te maak, wat dit dan sal laat bruin uitslaan óf deur dit versigtig met 'n kussinkie watte, in ammoniak gedoop, te dep. Dit sal dan blou uitslaan.

Eksperiment 35.—Skryf met 'n flou kobaltchloriedoplossing en wanneer dit droog is maak die papier warm met 'n vlammetjie. Die skrif sal blou uitslaan.

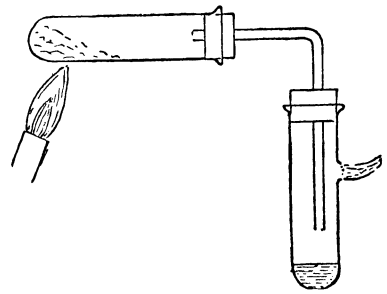
Eksperiment 36. Hoewel nie so doeltreffend as die bogenoemde stowwe nie, kan melk of suurlemoensap ook gebruik word. Die skrif word in albei gevalle ontwikkel deur dit naby 'n vlam te hou.

DIE VLAMTOETS VIR METAAL IN 'N VERBINDING

Eksperiment 37.—'n Interessante verskynsel wat benut kan word om metale in verbindings op te spoor, is dat wanneer die verbindings in 'n vlam gehou word, verskillende metale die vlam kenmerkend verkleur. Party verkleur egter glad nie die vlam nie. Hou 'n mespuntjie tafelsout (natriumchloried) oor 'n vlam. Die vlam word helder geel gekleur. Probeer nou wassoda – dieselfde helder geel vlam word gekry – wassoda is natriumkarbonaat. Alle natriumverbindings gee dieselfde helder geel vlam. Probeer nou weer met kopersulfaat. Dié keer is die vlam 'n helder blougroen kleur. Met kalsiumverbindings (gebluste kalk d.w.s. kalsiumhidroksied) word die vlam oranje.

'N MINIATUUR GASFABRIEK

Die eksperiment gaan jou 'n proefbuis kos maar dit is beslis die moeite werd.



Afb. 5
'n Miniatuur Gasfabriek

Eksperiment 38.—Druk 'n eengatprop met 'n glaspypie daarin, in die bek van 'n proefbuis. Maak die proefbuis net op een plek in die middel warm en blaas terselfder tyd in die buis sodra die glas sag is. Dit sal 'n gat in die proefbuis maak. Druk nou 'n prop met 'n gebuigde glaspypie daarin, in 'n ander proefbuis en druk die los end van die pypie in die prop van die proefbuis met die gat in. Maak die heel proefbuis omtrent 'n derde vol steenkoolstof, sit die prop weer terug en maak die buis warm. Eers liggies en dan baie warm. Heel spoedig word daar 'n bruin damp afgeskei wat dan na die regop proefbuis toe beweeg en gedeeltelik kondenseer. Gas (Onsuiwer steenkoolgas) blaas nou by die gat in die proefbuis uit. Dit sal brand. Die bruin olierige vloeistof in die proefbuis is koolteer – een van die belangrikste „neweprodukte" van die steenkoolbedryf. Baie stowwe

word uit teer vervaardig, onder andere benseen en fenol of karbolsuur, wat dan ook weer kleurstowwe, geneesmiddels en plofstowwe lewer. Die waterige vloeistof wat ook sigbaar is bevat ammoniak. Die reste wat oorbly in die horisontale proefbuis is kooks.

Eksperiment 39.–Herhaal bogenoemde eksperiment met hout i.p.v. steenkool. Die vloeistof wat nou afgeskei word bevat asynsuur en metielalkohol wat in brandspiritus gebruik word. Die gas wat by die gat in die proefbuis uitblaas is ook vlambaar. Die reste in die horisontale proefbuis is houtskool.

(Einde van eksperimente wat met stel No. 1A. gedoen kan word.)

DIE BUNSEN-BRANDER

Die Bunsen-brander is een van die skeikundige se belangrikste gereedskapstukke. Dit vergemaklik alle verwarmingstakies. Die vlam self kan ook deeglik ondersoek word. (Spiritusbrander – Kyk bl. 3). DIE BUNSEN-BRANDER WAT VERSKAF WORD IN STELLE NOS. 4 EN 5 IS NET VIR GEBRUIK MET KOOLGAS EN MOET NIE MET AARDGAS OF METAANGAS GEBRUIK WORD NIE.

Eksperiment 40.–Bekyk die Bunsen-vlam as die luggat onder toe is. Die vlam is geel, nie baie warm nie en liggewend. Maak nou die luggat oop en kyk hoe die vlam verander. Dit gee nou nie meer lig nie en is baie warmer. Strooi 'n paar ystervylsels deur die vlam. Elke brokkie gloei as dit deur die vlam trek. Vaste stowwe in vlam laat dit lig gee.

HOE OM 'N GLOEIKOUSIE TE MAAK

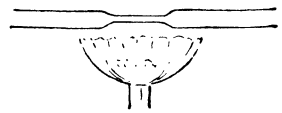
Eksperiment 41. Skep omtrent 'n halwe teelepelvol gebluste kalk in 'n indampbakkie en bedek dit met asyn. Maak die mengsel warm en week dan 'n stukkie gaas – 'n stukkie rolverband is uitstekend – daarin. Druk droog en hou dan die lappie met 'n tang in die vlam. Die gaas sal droog word en wegbrand, maar die fyn kalkdraadjies sal oorbly, en gloei dan met 'n helder wit lig. Dié eksperiment is veral treffend in 'n donker kamer en verklaar ook die doel van 'n gloeikousie.

Eksperiment 42.–Die nie-liggewende Bunsen-vlam bestaan uit twee dele. Die binnekeël is koud en bevat onverbrande gas. Hou 'n vuurhoutjie oor die vlam vir 2 of 3 tellings. Trek dit nou weg. Die gedeelte wat in die warm buitekeël was het geskroei terwyl die stukkie in die middel onaangeraak is. Sluit die gas af. Druk 'n kopspeld in die kop van 'n vuurhoutjie en balanseer dit oor die bek van die brander. Draai die gas oop en steek aan. Die vuurhoutjie se kop is nou in die binnekeël en sal nie brand nie.

Vir die meeste verhittingseksperimente gebruik die nie-liggewende vlam want die helder vlam is rokerig en sal die toerusting vol roet smeer.

HOE OM GLASBUISE TE BUIG, TREK EN SNY

Eksperiment 43.–'n „Visstert"-vlam is die dienlikste om glaspypies mee te buig. Gebruik die vlamspreier wat op die brander pas. Hou die pypie oor die vlam en draai dit stadig in die rondte. Hou dit nou in die vlam en die pypie sal vanself begin buig. Moenie die pypie dwing nie en laat dit stadig afkoel deur dit geleidelik uit die vlam te trek en dan weg te neem. Om 'n pypie te breek, vyl 'n groefie dwarsoor die pypie. Draai die pypie in 'n lap toe en breek dit soos 'n stokkie op die vylkeep.



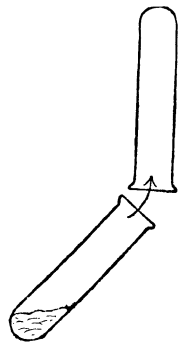
Afb. 6

Eksperiment 44.–Vir etlike van die eksperimente sal jy 'n pypie met 'n skerp tuit moet gebruik. Maak nou so 'n pypie. Maak 'n glaspypie warm soos in die vorige eksperiment. Sodra die glas begin sag word, trek die ente stadig van mekaar. Die glaspypie sal nou lyk soos in afbeelding 6. Laat dit afkoel en sny en breek dan die pypie. Maak die skerp punte van die pypie warm om hulle af te rond, maar wees versigtig of die pypie sal toesmelt.

WATERSTOF – DIE LIGSTE GAS

Eksperiment 45.–Maak 'n flou oplossing natriumbisulfaat en toets dit met lakmoes en campêchehout. Die reaksies toon dat dit 'n suur is. Dit reageer net soos 'n baie flou oplossing van die bekende swaelsuur.

Eksperiment 46.–Maak 'n natriumbisulfaat-oplossing in 'n proefbuis en gooi 'n korreltjie sink daarin. 'n Druppel kopersulfaat sal help om die reaksie aan te jaag. Die metaal los op en skei terselfdertyd gas af. Hou die bek van die proefbuis naby 'n vlam en die gas behoort met 'n blou vlam te brand of te ontplof met 'n pieperige plofgeluidjie. Dié gas is waterstof en is die ligste gas tans bekend.



Afb. 7
Hoe om waterstof „op" te vang

Eksperiment 47.–Gaan voort met die vorige eksperiment en vang die gas op deur 'n proefbuis onderstebo te hou oor die een met die vloeistof in. (Afb. 7) Druk jou duim oor die bek van die opvangproefbuis na 'n rukkie en hou dit dan weer naby 'n vlam. As die gas met lug vermeng is sal dit weer met die kenmerkende piepgeluid ontplof.

Eksperiment 48.–Waterstof kan gemaak word deur die werking van verskeie sure op die verskillende metale. Probeer weer die eksperiment maar gebruik ystervylsels i.p.v. sink. Moet egter nie die oplossing weggooi wanneer die eksperiment klaar is nie, bêre dit vir eksperiment 49.

Probeer ook 'n wynsteensuuroplossing met sink. 'n Druppel of wat kopersulfaatoplossing sal help om die reaksie aan te jaag.

Eksperiment 49.—Gaan voort met die eerste gedeelte van eksperiment 48. Filtreer die oplossing en vang dit op in 'n horlosieglas of vlak bakkie en laat dit vir 'n paar dae staan om te kristaliseer. Let op die liggroen kleur van die oplossing. Na 'n paar dae sal daar groen ferrosulfaat – of groen vitroelkristalle in die bakkie wees. Gooi die oorblywende vloeistof af en droog die kristalle met kladpapier af.

Eksperiment 50.—Maak 'n natriumbisulfaatoplossing in 'n proefbuis en voeg 'n bietjie koperoksied by. Die swart poeier los op en vorm 'n blou kopersulfaatoplossing. Voeg meer koperoksied by totdat die oplossing versadig is. Filtreer nou die oplossing en vang dit op in die erdebakkie. Damp 'n bietjie van die vloeistof af en laat staan dit dan om te kristaliseer. Droog die kristalle af met kladpapier.

Eksperiment 51.—Maak flou oplossings kopersulfaat en natriumkarbonaat (wassoda) in aparte buise, en meng die twee oplossings. 'n Blou koperkarbonaatneerslag word afgeskei. Filtreer die oplossing en was die presipitaat deur skoon water deur die tregter te gooi. Haal nou versigtig die filtreerpapier uit en sit dit op 'n skoon vel papier neer om droog te word. Die fyn blou poeier kan by 'n later geleentheid gebruik word (bv. eksperiment 53).

Eksperiment 52.—Maak 'n wit magnesiumkarbonaatpoeier op dieselfde wyse as die vorige eksperiment. Meng dié keer 'n magnesiumsulfaat- en natriumkarbonaatoplossing.

Eksperiment 53.—Druk 'n glaspypie in kalkwater. Druk nou die ent van die pypie toe met die wysvinger en trek die pypie uit die vloeistof. Deur die vinger effens te beweeg kan die kalkwater nou uitgedrup word, en met 'n bietjie oefening sal dit moontlik wees om 'n druppel op die punt van die pypie vas te vang sonder dat dit afval. Oefen 'n bietjie voor daar met die eksperiment voortgegaan word. Gooi nou 'n bietjie van die koperkarbonaat wat by eksperiment 51 oorgebly het in 'n proefbuis en maak dit warm. Vang nou 'n druppel kalkwater vas met 'n pypie en hou dit in die bek van die proefbuis. Die koperkarbonaat word swart koperoksied en die kalkwater word wit en dui aan dat koolstofdioksied vrygestel is. Dié metode van toets vir die teenwoordigheid van 'n gas is baie nuttig veral waar daar baie min gas is.

Eksperiment 54.—Hierdie eksperiment moet baie warm gemaak word. Maak 'n kroes halfvol marmerstukkies (marmer is kalsiumkarbonaat), en maak dit warm vir ten minste 'n uur. (Die kop van 'n gebreekte erdepyp met stukkies marmer gevul en in 'n gloeiende vuur gedruk sal uitstekend aan die doel beantwoord.) In die eksperiment gee die kalsiumkarbonaat koolstofdioksied af en die oorblywende stof is dan kalsiumoksied of ongebluste kalk.

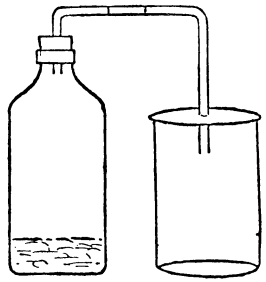
Eksperiment 55. Plaas die kroesie (sodra dit koud is) net binne bereik en drup dan baie versigtig water op die ongebluste kalk met die glaspypie soos in eksperiment 53 gedoen is. Elke druppel water veroorsaak 'n geweldige reaksie, die water sit oor in stoom en die kalk dy uit. Sodra die reaksie ophou is die kalk „geblus" en die stof

in die kroesie is dan kalsiumhidroksied. Die eksperiment verklaar hoe gebluste kalk gemaak word deur die kalkklip in oonde te brand en dan die ongebluste kalk wat gevorm word met water te blus.

Eksperiment 56.—Hoewel koolstofdioksied vrygestel kan word deur 'n karbonaat te verhit is dit makliker om dit te doen deur die werking van 'n suur op die karbonaat.

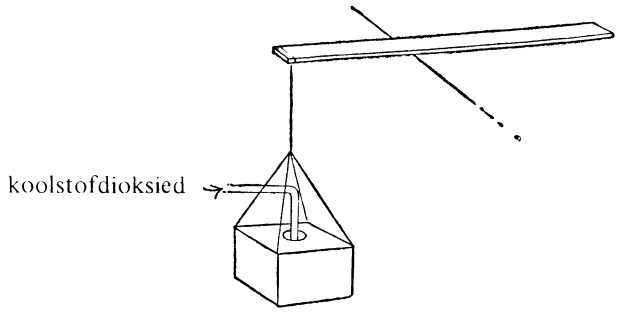
Maak 'n taamlike sterk wynsteensuuroplossing in 'n proefbuis en gooi 'n klein stukkie marmer daarin. Die oplossing bruis en koolstofdioksied word vrygestel. Toets soos voorheen met 'n druppel kalkwater.

Eksperiment 57.—Dieselfde bruiseffek word verkry met koolstofdioksied wat vrygestel word wanneer meeste ander sure inwerk op enige karbonaat. Probeer asyn met natriumkarbonaat.



Afb. 8
Hoe om 'n fles vol Koolstofdioksied te maak

Eksperiment 58.—Maak nou 'n paar flesse vol koolstofdioksied met behulp van 'n medisynebotteltjie, 'n eengatprop en 'n leweringsbuis, opgestel soos in Afb. 8. Die leweringsbuis word gemaak van die twee reghoekige buise, in die stel, wat verbind word met 'n stukkie gomlastiekpyp. Gooi in die bottel 'n klompie natriumkarbonaat wassoda), bedek dit met 'n wynsteensuuroplossing en sit gou die prop met die leweringsbuis op. Hou 'n brandende vuurhoutjie by die bek van die opvangfles. Sodra die vuurhoutjie geblus word is die fles vol. Vul twee of drie flesse gas en bedek elkeen met 'n stukkie karton. Let op dat die leweringsbuis ook deur 'n stuk papier of karton gaan wat dan die fles bedek terwyl die eksperiment aan die gang is. Die flesse gas kan in eksperiment 60 en 62 gebruik word.



Afb. 9 Eksperiment om te bewys dat koolstofdioksied 'n baie swaar gas is

Eksperiment 59.—Maak 'n papierkardoesie met 'n deksel en sny dan 'n gat so groot soos 'n tiensentstukkie in die deksel. Bind die

kardoesie aan die end van 'n ligte liniaal vas en balanseer die apparaatjie op 'n potlood of 'n soortgelyke skerp kant. (Afb. 9). Hou nou die end van die leweringspyp oor die gat in die kardoesie sodat dit vol koolstofdioksied word. Die liniaal dien as 'n skaaltjie en is heeltemaal toereikend om te bewys dat koolstofdioksied swaarder is as lug.

Eksperiment 60.—Nog 'n bewys dat koolstofdioksied 'n baie swaar gas is kan op die volgende manier gelewer word. Gebruik die fles gas wat in eksperiment 58 berei is of berei 'n fles vol soos voorheen. Blaas nou 'n seepbel en skud dit af in die fles. Wees versigtig en dit sal nie te moelik wees nie. Die seepbel sal op die gas dryf.

Eksperiment 61.—As 'n fles koolstofdioksied oop gelos word dan vermeng die gas met die lug en verdwyn. Dié proses is bekend as „diffusie". Eksperimente het bewys dat swaar gasse stadiger diffuseer of „meng" met die lug as ligte gasse. Doen self 'n eksperiment om diffusie te illustreer. Vul vier proefbuise met koolstofdioksied met die apparaat in Afb. 8. Sit die buise in 'n staander en maak al vier gelyk oop. Gebruik 'n horlosie met 'n sekondewyster vir die eksperiment. Gooi na 'n minuut 'n bietjie kalkwater in die eerste buis en skud goed. Die water sal wit word. Gooi 'n bietjie kalkwater in die tweede buis na twee minute en skud goed. Indien daarin nog koolstofdioksied voorkom, toets dan die derde buisie na drie minute ens. Dit is verrassend hoe lank dit duur vir die koolstofdioksied om heeltemaal te diffuseer.

Eksperiment 62.—Sit 'n kort kersie op die tafel neer en steek dit op. Gooi nou die koolstofdioksied daaroor uit die fles asof dit water is. Die gas vorm 'n „kombers" oor die vlam en smoor dit deur die lug af te sluit. Party brandblussers werk op dié beginsel. Hulle bevat 'n suur en 'n natriumkarbonaatoplossing wat dan vermeng word wanneer die blusser gebruik moet word. Dit „spuit" dan koolstofdioksied oor die vlamme.

Eksperiment 63.—Maak 'n proefbuis halfvol kalkwater en steek die leweringsbuis van die apparaat in afbeelding 8 daarin sodat die koolstofdioksied daardeur kan borrel. Die water word wit, maar hou aan. Geleidelik verdwyn die wit en die water word weer helder. Die wit kryt neerslag wat aanvanklik gevorm het los op as daar nog koolstofdioksied deur die water gepomp word; die stof wat nou opgelos is, is kalsiumbikarbonaat d.w.s. kalsiumkarbonaat met, as't ware 'n ekstra deel koolstofdioksied. Bêre die oplossing vir die volgende paar eksperimente.

Eksperiment 64.—Gooi 'n bietjie kalsiumbikarbonaatoplossing, uit die vorige eksperiment, in 'n skoon proefbuis. Gooi nou 'n krieseltjie seep daarby en skud goed. Die water skuim nie maar vorm 'n kimlaag. Water wat kalsiumbikarbonaat bevat en só reageer met seep is „harde" water.

Eksperiment 65.—Gooi 'n bietjie van die kalsiumbikarbonaat-oplossing in 'n proefbuis en verhit tot dit kook. Die ekstra koolstofdioksied word afgeskei, kalsiumkarbonaat word gevorm en maak die water weer wit. Filtreer die water en gooi weer 'n krieseltjie seep daarin. Skud goed. Nou skuim die water. Water word versag deur dit te kook.

Eksperiment 66.—Gooi 'n bietjie kalsiumbikarbonaatoplossing in 'n skoon proefbuis en voeg 'n bietjie ammoniak daarby. Die vloeistof word weer wit. Die kryt neerslag verskyn weer.

Eksperiment 67.—Voeg 'n bietjie wassoda (natriumkarbonaat) by die oorblywende kalsiumbikarbonaatoplossing. Die wit neerslag word weer gevorm. Hierdie eksperiment en die vorige een verduidelik hoekom daar ammoniak of wassoda in waswater gegooi word. Wanneer die water hard is as gevolg van die kalsiumbikarbonaat daarin, dan veroorsaak die middels dat die kalk neerslaan uit die water en sodoende versag dit die water.

Eksperiment 68.—Toets die water by jou huis vir kalsiumbikarbonaat. Herhaal die vorige eksperimente (a) kook die water, (b) voeg ammoniak by en (c) voeg wassoda by. Let op of die water wit word met enige van die toetse. (Die wit neerslag sal baie effens wys as daar net 'n bietjie kalsiumbikarbonaat in die water is).

Eksperiment 69.—Baie stowwe soos messelklei, die meeste grondsoorte en eierdoppe bevat kalk of kalsiumkarbonaat. Houtas bevat weer kaliumkarbonaat. Meng enige van die stowwe met 'n suuroplossing en toets vir koolstofdioksied met 'n druppeltjie kalkwater.

Eksperiment 70.—Baie „organiese" stowwe soos suiker en stysel bevat koolstof. Verhit die stowwe totdat hulle verkool en net die swart koolstof oorbly.

Meng 'n bietjie suiker en koperoksied en verhit dit in 'n proefbuis. Die koolstof in die suiker word nou afgeskei as koolstofdioksied. Toets met 'n druppel kalkwater. Die meeste koolstofhoudende stowwe sal só reageer met die proefneming.

NATRIUMHIDROKSIED OF SEEPSODA
HOE OM SEEP TE MAAK

Eksperiment 71.—Natriumhidroksied is een van die sterkste alkali's. Maak 'n flou oplossing deur 'n natriumkarbonaatoplossing te meng met 'n bietjie gebluste kalk in 'n ou koppie. Filtreer die oplossing in 'n bottel in en plak 'n etiket op die bottel.

Die oplossing voel glad en „seperig" — toets dit met rooi lakmoes of campêchehout om vas te stel of dit wel 'n alkali is. Die natriumhidroksiedoplossing is nie suiwer nie want dit sal nog 'n bietjie natriumkarbonaat bevat maar dit sal geen afbreuk doen aan die eksperimente wat jy daarmee uitvoer nie.

Eksperiment 72.–Voeg 'n bietjie natriumhidroksiedoplossing by 'n bietjie flou kopersulfaatoplossing in 'n proefbuis. 'n Blou koperhidroksiedneerslag word gevorm. Verhit nou die vloeistof. Die neerslag verdonker en word later swart – dit is nou koperoksied. (Kyk ook Eksperiment 26).

Eksperiment 73.–Voeg 'n bietjie natriumhidroksiedoplossing by 'n bietjie magnesiumsulfaat. 'n Wit magnesiumhidroksiedneerslag word gevorm.

Eksperiment 74.–Gooi 'n bietjie natriumhidroksiedoplossing in 'n erdebakkie en sit 'n stukkie vet daarin. Kook stadig vir 'n rukkie op 'n staander met 'n sifblad. Voeg nou 'n lepeltjie sout by en laat die mengsel afkoel. 'n Vaste stof – seep – sal bo-op dryf. Skep dit af en druk dit saam. Die maak van seep uit verskeie soorte vet en olie is een van die hoofgebruike van natriumhidroksied.

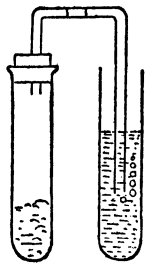
Eksperiment 75.–Maak 'n aluinoplossing (aluminiumsulfaat) in 'n proefbuis drup versigtig 'n bietjie natriumhidroksiedoplossing daarin. 'n Wit aluminiumhidroksiedneerslag word gevorm. Hou aan natriumhidroksied in drup en die neerslag sal verdwyn.

Eksperiment 76.–Gooi 'n stukkie sink in 'n bietjie natriumhidroksiedoplossing, in 'n proefbuis en maak dit liggies warm. Gasborreltjies – waterstof – word gevorm. Natriumhidroksied verteer sowel aluminium as sink, daarom moet daar nooit wassoda – wat 'n bietjie natriumhidroksied in die water vorm – in die water gegooi word wat aluminiumpotte in gewas gaan word nie.

Eksperiment 77.–Gooi 'n bietjie natriumhidroksiedoplossing in 'n proefbuis en sit daar 'n stukkie wol in. Maak die oplossing warm en die wol sal oplos. Dieselfde eksperiment met katoen sal nie die katoen laat oplos nie. Dit is ook 'n metode om tussen wol en katoen te onderskei. (Kyk eksperiment 15).

SWAELWATERSTOF – DIE „VROTEIERGAS"

Eksperiment 78.–Gooi 'n bietjie ferrosulfied in 'n proefbuis en gooi dan 'n sterk wynsteensuuroplossing daaroor. Skud goed en maak liggies warm. 'n Gas wat stink soos 'n vrot eier word gevorm. Dieselfde gas word, terloops, gevorm wanneer 'n eier vrot. Doop 'n stukkie filtreerpapier of kladpapier in 'n kopersulfaatoplossing en hou dit naby die bek van die proefbuis. Die papier word swart.



Afb. 10
Hoe om 'n swaelwaterstofoplossing te maak

Eksperiment 79.–Die gas wat in die vorige eksperiment gevorm is, is swaelwaterstof. Die gas los op in water en dus kan 'n oplossing daarvan gemaak word wat baie bruikbaarder is as die gas. Herhaal die vorige eksperiment maar druk 'n eengatprop met 'n leweringsbuis in die bek van die proefbuis en druk die oop ent van die leweringsbuis in 'n proefbuis halfvol water. (Kyk afb. 10.) Verhit die toe proefbuis totdat daar nie meer gas afgeskei word nie en neem dit dan dadelik weg van die proefbuis met die oplossing in.

Eksperiment 80.–Voeg 'n bietjie swaelwaterstofoplossing by 'n bietjie kopersulfaatoplossing. 'n Swart kopersulfiedneerslag word gevorm. Die vorming van die neerslag is die basis van die toets vir swaelwaterstof in eksperiment 78.

Eksperiment 81.–Maak 'n flou kobaltchloriedoplossing en voeg daar 'n bietjie swaelwaterstofoplossing by. Daar is geen neerslag nie want die kobaltsulfied los op in die soutsuur wat ook in die vloeistof gevorm is. Voeg egter nou 'n bietjie ammoniak by. Die ammoniak neutraliseer die soutsuur en 'n swart neerslag word gevorm.

Bêre die oorblywende swaelwaterstofoplossing vir latere eksperimente.

SWAELDIOKSIED – BLEIKGAS

Eksperiment 82.–Maak 'n natriumbisulfietoplossing en voeg 'n bietjie swaelwaterstofoplossing by. 'n Skerp, kleurlose gas, swaeldioksied, word afgeskei. Die gas los egter op in water en heelwat bly dus agter in die oplossing waar dit swaeligsuur vorm. Dit is 'n baie interessante oplossing wat nou gevorm is, soos die volgende eksperimente dan ook sal aandui.

Eksperiment 83.–Sit 'n gekleurde blom in 'n fles met 'n bietjie swaeligsuur. Bedek die fles met 'n stuk karton en laat dit vir 'n rukkie staan. Blou blomme gee gewoonlik die beste resultate. Na 'n rukkie sal die blom wit gebleik wees. Probeer nou een of twee stukkies geel strooi in die vloeistof. Swaeldioksied word veral gebruik om strooi te bleik. Die oplossing word ook gebruik om vrugte te preserveer. Pruime word byvoorbeeld daarin ingelê – die vrugte word dan meteens ook gebleik.

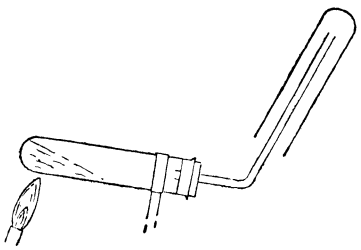
Eksperiment 84.–Meng 'n bietjie swaelwaterstofoplossing en 'n bietjie swaeldioksiedoplossing in 'n proefbuis en laat dit vir 'n rukkie staan. Indien die oplossings sterk genoeg is behoort die vloeistof na 'n rukkie geleidelik te begin vertroebel, as gevolg van die afskeiding van swael. Die swael word afgeskei deurdat die waterstof van die swaelwaterstof verbind met die suurstof van die swaeldioksied om water te vorm en sodoende word die swael van albei die oplossings vrygestel.

'N PAAR EKSPERIMENTE MET AMMONIAK

Ammoniak is 'n baie bekende stof wat in die meeste huise gevind kan word. Een van die redes waarom dit huishoudelik gebruik word is in eksperiment 66 aangedui. Die volgende eksperiment behoort heelwat duidelik te maak i.v.m. hierdie interessante en belangrike stof. Vir die eksperimente wat ammoniak vereis, gebruik huishoudelike ammoniak indien u nie genoeg berei met eksperiment 88 nie.

Eksperiment 85.—Verhit 'n bietjie ammoniumchloried (salmiak) in 'n droë proefbuis. Die wit stof smelt nie maar vorm 'n damp wat dan weer teen die koue kante van die proefbuis kondenseer. Hierdie verskynsel staan bekend as sublimasie. Miskien het jy 'n stukkie „metabrandstof" wat soms gebruik word by primusstowe en speelgoed modelle. Die stof sublimeer ook wanneer dit verhit word.

Eksperiment 86.—Meng 'n bietjie ammoniumchloried en gebluste kalk op 'n stukkie papier in gelyke hoeveelhede en vryf die mengsel deurmekaar met 'n staffie of 'n potlood. Let op die ammoniakreuk wat afgeskei word. Hou nou 'n stukkie klam rooilakmoespapier oor die mengsel (maar moenie dat dit die lakmoespapier raak nie). Die lakmoespapier word blou want ammoniak is 'n alkaligas, dit is in der waarheid die enigste alledaagse alkaligas.



Afb. 11
Ammoniakgas word opgevang

Eksperiment 87.—Vang 'n bietjie ammoniakgas op deur 'n mengsel van ammoniumchloried en gebluste kalk in 'n proefbuis te verhit. Druk 'n eengatprop met 'n reghoekig gebuigde leweringsbuis daarin, in die bek van die proefbuis (afb. 11). Let op dat die proefbuis afdraand lê. In die eksperiment word ook 'n bietjie water gevorm en dit verhoed dat die water terugloop na die warm onderent van die proefbuis. Die gas, wat ligter is as lug word opgevang deur 'n droë proefbuis oor die leweringsbuis te hou.

Eksperiment 88.—Vang 'n proefbuisvol gas op soos in die vorige eksperiment en sit die proefbuis onderstebo neer in 'n bakkie water. Ammoniak los baie maklik op in water en dus sal die water vinning in die proefbuis opstyg namate die gas oplos. Die oplossing is werklik bekend as ammoniumhidroksied maar word in die spreektaal sommer ammoniak genoem.

Los 'n hele paar buise gas so op in so min water as moontlik en gebruik die oplossing vir die volgende eksperimente.

Eksperiment 89.—Maak 'n kopersulfaatoplossing in 'n proefbuis en voeg 'n paar druppels ammoniakoplossing daarby. 'n Blou koperhidroksiedneerslag word gevorm. Voeg nou nog ammoniakoplossing by en die neerslag verdwyn terwyl die vloeistof heeltemaal verdonker. Dit is 'n goeie toets vir die teenwoordigheid van 'n kopersout. Herhaal die eksperiment met 'n kopersulfaatoplossing wat so flou is dat die blou kleur byna onsigbaar is. Voeg die ammoniakoplossing by en let op hoe die blou kleur ontwikkel.

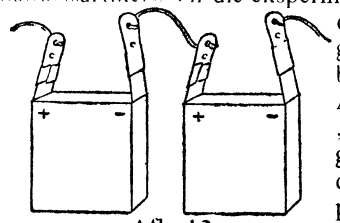
Herhaal nou eksperiment 73 maar gebruik ammoniakoplossing i.p.v. natriumhidroksied.

Eksperiment 90.—Die eksperiment veroorsaak 'n miniatuur rookskerm. Meng 'n bietjie ammoniumchloried met 'n bietjie gebluste kalk in 'n proefbuis en natriumchloried (tafelsout) en natriumbisulfaat in 'n ander proefbuis. Sodra laasgenoemde mengsel warm gemaak word, word 'n mistige damp, soutsuurgas, afgeskei. Hou nou die bekke van die proefbuise naby mekaar en verhit die proefbuise. Twee kleurlose gasse word afgeskei (ammoniak en soutsuurgas). Sodra die twee gasse meng word 'n digte wit wolkdamp gevorm, wat bestaan uit ammoniumchloried deeltjies.

(Einde van eksperimente wat met stel No. 2 gedoen kan word)

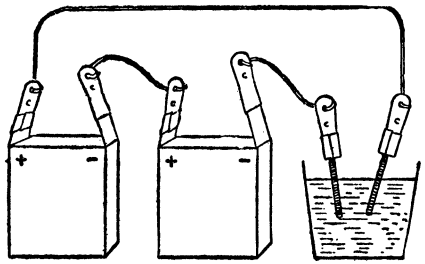
'N PAAR ELEKTROCHEMIESE EKSPERIMENTE

Elektrisiteit speel deesdae 'n belangrike rol in vele skeikundige prosesse. Die doel van die wetenskap waar elektrisiteit gebruik word om chemiese reaksies te veroorsaak is bekend as elektrochemie. Daar is 'n hele aantal eenvoudige dog interessante eksperimente in die elektrochemie wat uitgevoer kan word met die chemikalieë en apparaat in stelle Nos. 3, 4 en 5. Baie van die eksperimente illustreer nywerheidsprosesse bv. die vervaardiging van seepsoda en natriumhipochloriet, (albei baie nuttige en belangrike stowwe in sowel die huis as in die laboratorium) en ook die elektroplatering van handelsartikels. Vir die eksperimente moet, benewens die apparaat in die stel, ook 'n 4½ volt droë battery gebruik word of twee gewone flitsbatterye wat gekoppel word soos in Afb. 12. Elke battery het twee „pole" of kontakpunte. Die kort geelkoperplaatjie van 'n flitsbattery is die positiewe pool en die lang plaatjies is die negatiewe pool. Ontbloot die ente van 'n stukkie geïsoleerde koperdraad en koppel die negatiewe pool van die een sel aan die negatiewe pool van die ander met behulp van die batteryklampies in die stel. Die batterye is nou „in serie" geskakel. Gebruik nou die twee saam as een battery met 'n positiewe en 'n negatiewe pool.



Afb. 12
Batterye in serie geskakel

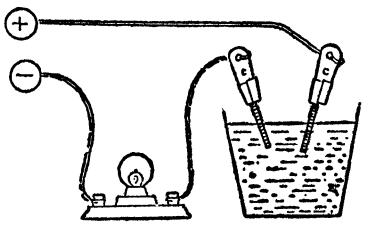
Eksperiment 91.—Ontbloot die ente van twee stukke geïsoleerde koperdraad en verbind een ent van elk met 'n battery pool. Koppel die los ente aan die koolstofstaffies of „elektrodes". Steek nou die elektrodes in 'n eierkelkie of 'n klein glasie vol water. (Kyk Afb. 13).



Afb. 13

Moenie teleurgestel wees indien daar niks gebeur nie, dit bewys dat suiwer water 'n nie-geleier is van elektrisiteit, daarom sal daar dan ook geen stroom vloei nie.

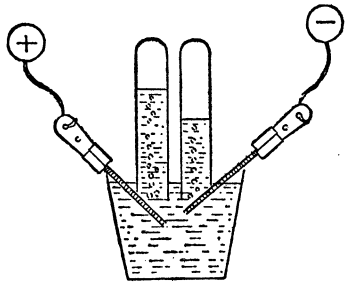
Voeg nou 'n lepeltjie sout by die water. Dadelik word daar gasborreltjies gevorm aan die elektrodes. 'n Elektriese stroom vloei nou en veroorsaak 'n chemiese reaksie. Die stroom sal ook vloei as natriumsulfaat of ferrosulfaat of enige ander sout in die water opgelos word. Stowwe wat water 'n geleier maak word elektroliete genoem.



Afb. 14

Eksperiment 92.–Herhaal die vorige eksperiment, maar gebruik die keer suiker of stysel i.p.v. sout. Die stowwe is nie elektrolities nie en veroorsaak dus geen reaksie nie. As jy oor 'n gloeilampie en 'n gloeilamphouertjie beskik, las dit dan in die stroombaan soos in Afb. 14. Die eksperiment is nou meer treffend. Sodra die krag vloei – d.w.s. wanneer daar 'n sout in die water is – sal die liggie brand, maar nie wanneer daar suiker in die water is nie.

Eksperiment 93.–Los 'n hoogvol teelepel Glaubersout (natriumsulfaat) op in 'n eierkelkie water en druk die elektrodes daarin soos voorheen. Maak 'n proefbuis vol water en hou dit toe met die duim. Keer die proefbuis om en druk dit in die water in oor een van die elektrodes, bv. die een wat aan die kort positiewe pool gekoppel is. Vang nou die gas op wat afgeskei word. (Kyk Afb. 15). As die proefbuis halfvol gas is druk dit dan weer toe en keer dit om met die bek na bo. Druk nou 'n gloeiende stokkie in die proefbuis. Die hout slaan aan die brand, die gas moet dus suurstof wees. Herhaal nou maar vang die gas op wat van die negatiewe pool af kom. Sodra die buis byna vol is haal dit soos die vorige keer uit die eierkelkie en hou die bek naby



Afb. 15
Opvang van gasse tydens die waterelektroliese

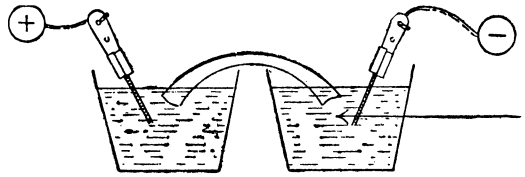
'n vlam. Die gas sal brand of ontplof, dit is dus waterstof. Hoewel nie maklik in 'n eierkelkie nie is dit tog moontlik om twee proefbuise gelyktydig in die eierkelkie te druk. Dit sal dan vir jou bewys dat waterstof tweekeer so vinnig afgeskei word as suurstof. Die proses is bekend as waterelektroliese.

Eksperiment 94. Die eksperiment wat nou beskryf word is nie net een van die interessantste nie maar illustreer ook hoe 'n aantal belangrike stowwe vervaardig word.

Gooi twee teelepels sout in 'n eierkelkie water en voeg 'n bietjie rooilakmoesoplossing by. Steek die gekoppelde elektrodes in die oplossing en hou dop. Die vloeistof om die positiewe elektrode verbleik terwyl die vloeistof om die negatiewe elektrode blou word, deurdat 'n alkali gevorm word. Gas word ook by die elektrode afgeskei. Die alkali wat gevorm word is natriumhidroksied of seepsoda wat volgens 'n ander metode in eksperiment 71 berei word. Die lakmoes word by die positiewe pool gebleik deur die gas chloor. Die gas is nie juis duidelik sigbaar nie, want dit los geweldig vinnig op in die water, maar die reuk van die gas sal duidelik waarneembaar wees.

In hierdie eksperiment is natriumhidroksied, waterstof (die gas wat by die negatiewe elektrode gevorm is), en chloor gevorm deur net soutwater en 'n elektriese stroom te gebruik.

Eksperiment 95.–As jy die natriumhidroksied apart wil hou moet die eksperiment so opgestel word dat dit nie in dieselfde bakkie vorm as die chloor nie. Dit kan gedoen word deur die eksperiment op te stel soos aangedui in Afb. 16. Maak twee eierkelkies vol sterk soutwater en koppel hulle met 'n breë strokie kladpapier Die kladpapier sal van die soutwater opsuig en 'n skakel vorm tussen die



Afb. 16
Natriumhidroksied word gevorm

twee kelkies. Steek nou 'n elektrode in elkeen van die kelkies. Elektroliese vind weer plaas maar die natriumhidroksied word in die een kelkie gevorm – die een wat met die negatiewe elektrode gekoppel is – en chloor in die ander kelkie. Laat die eksperiment vir ongeveer tien minute voortgaan voor dit onderbreek word. Doen nou weer eksperimente 72 tot 77 met die natriumhidroksied wat deur elektroliese gemaak is. Doen ook die volgende eksperimente.

Eksperiment 96.–Maak 'n flou kobaltchloriedoplossing en voeg 'n bietjie natriumhidroksiedoplossing daarby. 'n Blou kobalthidroksied-

neerslag word gevorm. Maak die proefbuis warm. Die blou neerslag word nou pienk.

Eksperiment 97.—Voeg 'n bietjie natriumhidroksiedoplossing by 'n flou ferrosulfaatoplossing. 'n Groen ferrohidroksiedneerslag word gevorm. Druk die bek van die proefbuis dig toe en skud vir 'n rukkie baie goed. Die groen neerslag word geleidelik bruin deur dit met die suurstof in die lug verbind en oksideer tot ferrohidroksied.

Eksperiment 98.—In plaas daarvan om die chloor en die natriumhidroksied,tydens elektroliese gevorm,te skei moet hulle liefs vermeng om sodoende 'n heel nuwe stof te vorm. Gaan soos volg te werk. Maak 'n sterk soutoplossing in 'n eierkelkie en sit albei die koolstofelektrodes daarin sonder dat hulle aan mekaar raak. Beweeg hulle gedurig in die vloeistof rond sodat die chloor en die natriumhidroksied goed kan meng. Hou so aan vir ongeveer tien minute en staak dan die eksperiment. Let op die reuk van die vloeistof – dit behoort baie bekend te ruik – bv. Milton of Jik. Die oplossing wat so pas gemaak is bevat natriumhipochloriet, wat vir die volgende eksperimente gebruik kan word.

Eksperiment 99.—Voeg 'n bietjie natriumhipochlorietoplossing by 'n lakmoesoplossing. Die kleur verdwyn – Dis uitgebleik. Probeer nou met 'n campêchehoutoplossing en ook met die vrugtesappe wat voorheen gebruik is. Natriumhipochloriet is 'n uitstekende bleikmiddel.

Eksperiment 100.—Skryf op 'n vel papier met gewone ink, laat dit droog word en druk dan liggies op die skrif met 'n kussinkie wat in natriumhipochloriet gedoop is. Die skrif verdwyn soos die ink gebleik word. Die oplossing kan dus gebruik word as 'n inkuitwisser.

Eksperiment 101. Voeg asyn by 'n bietjie van die natrium-hipochlorietoplossing en ruik versigtig daaraan. Chloor word afgeskei. Dit ruik soos bleikpoeier of swembadwater, bleikpoeier word dikwels gebruik om swembaddens mee te steriliseer.

Eksperiment 102.—Maak 'n flou ferrosulfaatoplossing, voeg 'n krieseltjie natriumbisulfaat by en dan 'n bietjie natriumhipochloriet. Die groen oplossing word geel namate die ferrosulfaat oksideer om ferrosulfaat te vorm. Voeg nou ammoniak- of natriumhidroksied-oplossing by. 'n Bruin ferrohidroksiedneerslag word gevorm.

Eksperiment 103.—Jy sal seker 'n hipochloriet-tipe bleikmiddel soos Milton of Jik in die huis hê. Probeer 'n paar van die bostaande eksperimente en kyk of jy dieselfde resultate kry.

Eksperiment 104.—Maak 'n sterk soutoplossing in 'n eierkelkie. Druk die twee kaal koperdrade daarin (haal die batteryklampies en die elektrodes af vir hierdie eksperiment). Waterstof word weer by die negatiewe pool gevorm maar die chloor wat by die positiewe pool gevorm word vreet aan die koperdraad en vorm koperchloried, wat die oplossing groen verkleur.

Eksperiment 105.—Bewys dat die oplossing in die vorige eksperiment koper bevat deur ammoniak by te voeg. Die oplossing word 'n diep blou kleur. (Kyk eksperiment 89).

Eksperiment 106.—Herhaal eksperiment 104, maar gebruik 'n blink spyker vir 'n positiewe elektrode. Die oplossing word weer groen en 'n groen neerslag word gevorm as die vloeistof geroer word. Die neerslag is ferrohidroksied wat ontstaan het uit die natrium-hidroksied wat by die negatiewe elektrode gevorm is en die ferrochloried wat by die positiewe elektrode gevorm is.

Eksperiment 107.—Gooi 'n deel van die oplossing en neerslag van die vorige eksperiment, in 'n skoon proefbuis en skud dit deeglik vir 'n rukkie. Die groen neerslag word geleidelik bruin terwyl dit suurstof uit die lug neem en oksideer om ferrohidroksied te vorm.

ELEKTROPLATERING

In eksperiment 33 het jy 'n stukkie yster met koper geplateer deur dit in 'n kopersulfaatoplossing te doop. Die lagie koper was egter nie baie heg nie. 'n Sterker laag van een metaal kan op 'n ander metaal geplaas word deur elektroplatering. Enige klein voorwerpie kan deeglik soos volg vernikkel word.

Eksperiment 108.—Doen eers die eksperiment met 'n strokie koper of geelkoper. Maak die strokie baie goed skoon. Maak nou 'n nikkelammoniumsulfaatoplossing in 'n eierkelkie. Heg die draad van die negatiewe pool van die battery aan die geelkoperstrokie – gebruik 'n knypertjie hiervoor. Koppel weer, soos voorheen, 'n koolstofstaffie aan die positiewe pool van die battery. Steek nou die geelkoperstrokie en die koolstof elektrode in die oplossing en hou die strokie dop. Die geelkoper word geleidelik bedek met 'n lagie nikkel. Haal die strokie uit die oplossing sodra dit deeglik vernikkel is. Spoel af en vryf dit blink op. Die blink nikkellaag sal nie sonder moeite afgeskuur kan word nie.

Eksperiment 109.—Maak 'n flou kopersulfaatoplossing en voeg 'n bietjie natriumbisulfaat daarby. Herhaal nou die vorige eksperiment en gebruik hierdie oplossing om 'n lagie koper op die geelkoper aan te bring.

(Dit is nie moontlik om met die eenvoudige apparaat yster te verkoper nie. Die maklikste metode om yster te verkoper is om dit in 'n kopersulfaatoplossing te „week".)

EKSPERIMENTE MET KALIUMJODIED

Kaliumjodied is 'n peperduur chemikalie, dus is die kaliumjodied in die stel nie suiwer nie. Die onsuiwerhede daarin sal egter geen invloed hê op die onderstaande eksperimente nie, of op enige ander eksperimente wat jy met die stel sal kan doen nie. Maak, geriefshalwe, 'n proefbuis vol oplossing (kaliumjodied los maklik op in koue water), en gebruik dan bietjies daarvan vir die volgende eksperimente.

Eksperiment 110.–Meng 'n bietjie natriumbisulfaat met kaliumjodiedoplossing en voeg dan 'n bietjie natriumhipochlorietoplossing by. Waterstofperoksied sal dien as plaasvervanger vir die natriumhipochloriet. Albei die stowwe is sterk joderingsmiddels, wat die jodium in kaliumjodied vrystel. Die vrygesette jodium kleur die oplossing bruin. Jy het dus nou 'n jodiumoplossing wat later (bv. by eksperiment 114) gebruik kan word.

Eksperiment 111.–Maak 'n bietjie stysel aan met koue water tot dit 'n dik room vorm. Gooi nou die styselroom in 'n driekwartkoppie kokende water, roer deeglik en laat dit afkoel.

Eksperiment 112.–Meng 'n bietjie jodiumoplossing met 'n bietjie styselwater. Die vloeistof word 'n intense blou kleur. Die blou vloeistof kan gebruik word as 'n baie gevoelige toets vir jodium of stysel. Gebruik die blou vloeistof vir die volgende eksperiment.

Eksperiment 113.–Maak 'n bietjie van die blou vloeistof, uit die vorige eksperiment, warm. Die blou kleur verdwyn. Verkoel nou die oplossing deur die proefbuis af te spoel met koue water. Die blou kleur verskyn weer. Hierdie handeling kan etlike kere herhaal word.

Eksperiment 114.–Voeg 'n bietjie natriumtiosulfaatoplossing by 'n bietjie van die jodiumoplossing wat jy in eksperiment 110 gemaak het. Die bruin kleur verdwyn. Die kleur kan ook verbleik word deur 'n bietjie swaeligsuur (van eksperiment 82) by die jodiumoplossing te voeg i.p.v. die natriumtiosulfaat.

Eksperiment 115.–Maak 'n bietjie natriumbisulfietoplossing en voeg daarby 'n bietjie van die blou oplossing uit eksperiment 113. Die kleur verdwyn.

Eksperiment 116.–Voeg 'n bietjie natriumtiosulfaatoplossing by 'n bietjie van die blou oplossing uit eksperiment 113. Net soos in die vorige eksperiment, word die jodium onttrek uit die vloeistof en die blou kleur verdwyn.

Eksperiment 117.–Voeg 'n bietjie speeksel by die oorblywende gedeelte van die blou vloeistof uit eksperiment 113. Laat die proefbuis 'n rukkie staan. Die blou kleur verdwyn geleidelik. Die eksperiment illustreer 'n baie interessante en belangrike saak. Die blou kleur van die oplossing was te wyte aan die teenwoordigheid van stysel, maar speeksel verteer die stysel en vorm suiker, wat geen uitwerking het op jodium nie. Die blou kleur sal dus verdwyn. Hierdie verandering van stysel in suiker by kossoorte soos aartappels, brood ens., moet in die mond plaasvind, daarom is dit so belangrik om jou kos behoorlik te kou.

Eksperiment 118.–Na aanleiding van die voorafgaande eksperiment sal dit interessant wees om te toets of kossoorte soos brood, aartappels, rys, ens., wel stysel bevat. Maak elkeen van bogenoemde kosse warm in 'n proefbuis met water. Laat die buise afkoel. Voeg nou 'n bietjie jodiumoplossing by, die blou kleur word weer gevorm. Onthou, net soos in eksperiment 113 sal die vloeistof nie blou word terwyl dit warm is nie.

Eksperiment 119.–Maak 'n flou kaliumjodiedoplossing en voeg daarby 'n bietjie styselwater, (kyk eksperiment 111) en 'n bietjie natriumbisulfaat. Skryf met die kleurlose oplossing op 'n vel papier. Die skrif word tevoorskyn gebring deur die papier liggies te bedruk met 'n kussinkie wat in 'n natriumhipochlorietoplossing (eksperiment 98) gedoop is. „Milton" of „Jik" kan ook gebruik word.

As jy 'n vriend het wat ook belangstel in skeikundige eksperimente kan julle vir mekaar skryf met die simpatetiese inksoorte wat in die boekie voorkom en dan probeer om mekaar se skrif uit te bring.

EKSPERIMENTE MET NATRIUMTIOSULFAAT

'n Paar eksperimente met natriumtiosulfaat is reeds beskryf. Die chemikalie word in die fotografie gebruik. Die volgende eksperiment, indien dit noukeurig gedoen word, illustreer kristalvorming baie mooi.

Eksperiment 120.–Gebruik 'n silwerskoon (verkieslik ongebruikte) proefbuis. Maak dit halfvol natriumtiosulfaatkristalle, en sit die buis in 'n koppie warm water. Die kristalle smelt en vorm 'n kleurlose vloeistof. Haal die proefbuis uit die water knyp dit vas op 'n staander. As die buis roerloos bly staan tot dit koud is sal die vloeistof nie kristaliseer nie. Gooi, sodra die vloeistof koud is, 'n natriumtiosulfaatkristal daarin. Kristalle begin dadelik vorm en vermeningvuldig totdat die vloeistof solied is. Dit is boeiend om te kyk hoe kristalvorming plaasvind. As 'n gewone oplossing moet kristalliseer duur die proses ure of self dae, in die eksperiment vind kristalvorming in 'n oogwink plaas.

Eksperiment 121.–Maak 'n flou natriumtiosulfaatoplossing in 'n proefbuis. Voeg 'n bietjie wynsteensuur by. Die vloeistof word geleidelik wit. Die suur stel die swael in die natriumtiosulfaat vry. Die swael slaan egter nie, soos gewoonlik, neer nie, dit bly in die vloeistof vasgevang en laat dit dan soos melk lyk.

As die eksperiment in 'n glas gedoen word en 'n brandende kers word agter die glas neergesit dan lyk dit of die kleur verander saam met die hoek waaruit die glas beskou word. 'n Paar interessante „sonsondergang"-verskynsels kan so waargeneem word.

BORAKSPÊRELTOETSE

Eksperiment 122.–Verhit 'n paar borakskristalle (natriumtetraboraatdekahidraat) op 'n blikdekseltjie. Die kristalle dy-uit namate kristallisasie water verdamp. Hou aan verhit vir 'n rukkie en laat die boraks dan afkoel. Daar behoort nou 'n deurskynende boraks „glaslagie" in die blikkie te wees. Plaas 'n enkele kobaltchloriedkristal op die boraks, smelt weer en laat dit weer afkoel. Die boraks sal nou 'n lieflike blou kleur wees.

Verskillende metaalverbindings gee elk 'n kenmerkende kleur met boraks, op die wyse. Die toets is meer doeltreffend indien 'n borakspêreltjie gemaak word en die kleinste moontlike hoeveelheid van die toetsstof gebruik word, soos in die volgende eksperiment.

Eksperiment 123.—Trek 'n punt in 'n glaspypie (soos in eksperiment 44). Maak die punt warm en druk dit liggies in die boraks sodat daar 'n bietjie boraks kan bly kleef. Verhit dit in 'n vlam. Die boraks dy weer uit en vorm 'n deurskynende glasagtige pêreltjie. Tel nou met die pêrel die kleinste moontlike kobaltchlorieddeeltjie op en smelt weer. Die pêreltjie behoort nou kobaltblou te word. Breek die pêreltjie af en herhaal die eksperiment met kopersulfaat (koper maak 'n groen pêrel), ferrosulfaat (ysterverbindings maak geel of groen pêrels), en nikkelammoniumsulfaat ('n bruin pêrel sal gevorm word deur die nikkel).

Eksperiment 124.—Maak 'n flou boraks-oplossing en doen 'n paar dubbele-samestellingseksperimente met kobaltchloried-, kopersulfaat-, nikkelammoniumsulfaat-, en aluinoplossings.

NIKKELAMMONIUMSULFAAT

Hierdie verbinding is 'n goeie voorbeeld van wat bekend is as 'n „dubbelsout" — dit bevat tegelyk nikkelsulfaat en ammoniumsulfaat en tog is dit nie net 'n gewone mengsel nie.

Eksperiment 125.—Meng 'n bietjie nikkelammoniumsulfaat en 'n bietjie gebluste kalk in 'n proefbuis en verhit. Let op die ammoniakreuk wat afgeskei word. Toets vir ammoniak met 'n stukkie klam lakmoespapier naby die bek van die proefbuis — die rooi lakmoespapier word blou.

Eksperiment 126.—Maak 'n flou nikkelammoniumsulfaatoplossing in 'n proefbuis voeg 'n bietjie swaelwaterstofoplossing (Eksperiment 79) by. Geen verandering behoort opgemerk te word nie. Voeg nou 'n bietjie ammoniak by. 'n Swart nikkelsulfiedneerslag word gevorm. Hier reageer die nikkel net soos die kobalt in eksperiment 81.

Eksperiment 127.—Hoe lyk nikkelhidroksied? Voeg 'n bietjie natriumhidroksiedoplossing by 'n nikkelammoniumsulfaatoplossing en kyk hoe lyk die neerslag.

ENKELE EIENAARDIGE EIENSKAPPE VAN HOUTSKOOL

Eksperiment 128.—Skud 'n swaelwaterstofoplossing (Eksperiment 79) met 'n stukkie houtskool in 'n proefbuis of 'n bottel met 'n prop op. Na 'n rukkie sal die stank van die swaelwaterstof feitlik heeltemaal verdwyn. Houtskool, veral sekere vorme daarvan, absorbeer geredelik gasse, daarom word dit in gasmaskers gebruik.

Eksperiment 129.—Houtskool absorbeer nie net gas nie maar ook kleurstowwe in 'n oplossing. Kook 'n stukkie houtskool in 'n lakmoesoplossing vir 'n rukkie en filtreer dan die vloeistof. Die oplossing sal nou heelwat bleker wees as wat dit aanvanklik was. Indien die oplossing aanvanklik flou was sal dit moontlik heeltemaal kleurloos wees.

Eksperiment 130.—Herhaal die voorafgaande eksperiment met 'n campêchehoutoplossing, ink verdun met water en 'n paar ander gekleurde oplossings.

Eksperiment 131.—Maak 'n bietjie houtskool deur 'n paar stukkies hout in 'n proefbuis te verkool — of gebruik die houtskool wat oorgebly het by eksperiment 39. Herhaal nou die vorige eksperimente (128-130) hiermee. Jy behoort dieselfde resultate te kry hoewel miskien nie so oortuigend nie soos reeds genoem is, gee sommige soorte houtskool beter resultate as ander.

Die eksperimente in hierdie boekie is, soos in die inleiding gesê is, maar 'n paar van die vele wat met jou stel gedoen kan word. Self die eenvoudigste eksperiment kan by herhaling iets oplewer wat nie voorheen raakgesien is nie, daarom is wetenskaplike eksperimente nooit oninteressant nie. As jy miskien dink jy het 'n oorspronklike eksperiment, of jy stel besonder belang in jou stokperdjie, of as jy 'n verduideliking wil hê van iets wat jy nie snap nie — vra dan die skeikunde onderwyser — hy sal graag wil help of raad gee.

SKEIKUNDEAPPARAAT EN BYBEHORE

†810 **Absorpsiebuis.** U-vorm 4" x ½" gerand
808 Asbesplaatjie 5¼" x 5¼".
†811 Beker, glas, 50 ml.
†809 Byekorfstaander
†826 Blaaspyp 7".
827 Bottel, glas, met prop, 2 ons.
868 Bottel, politeen, met prop, 4 ons.
†800B Bunsen-brander (Kyk voetnoot)
†869 Bunsen-brander, vlamspreier.
†872 Buret met kraantjie, 10 ml.
812 Koolstofstaffie 1" x 1/8".
873 Houtskoolblokkie 2" x 1¼" x 1¼".
†874 Chemieskaal.
875 Chemieskaal, stel gewiggies (m g.)
†813 Kroes 15 ml.
†814 Kroesdeksel
†815 Kroestang 6½".
†876 Ontbrandingslepel en deksel
†877 Leweringsbuis
†817 Drup-pipet met gomlastiekbol.
818 Indampbakkie 42 ml.
797 Filtreerpapier 3" (Pakkie van 12)
821 Filtreerpapier 3" (Pakkie van 100)
†878 Keëlfles (Hittebestand), 100 c.c.
†822 Fles, platboom, 50 c.c.
†879 Fles, platboom, (Hittebestand) 100 c.c.
†819 Tregter, filtreer, glas, 2"
820 Tregter, plastiek
†837 Tregterbuis, 12"
†880 Gasfles 6" x 2", met deksel
*824 Glaspypies, 1/10" buitemaat, 3" lengtes
*825 Glaspypies, 1/10" buitemaat, 12" lengtes
*796 Glaspypies, 5/16" buitemaat, 12" lengtes
871 Handleiding No. 0 (net geskik vir stelle 0 en 0A.)
828 Handleiding No. 1-5.
829B Lakmoespapier, blou (20 velle per boekie)
829R Lakmoespapier, rooi, (20 velle per boekie)

881 Magnesiumlint
†882 Maatsilinder, 100 ml., gegradueer
†883 Maatglas, 2 ons, gegradueer
†830 Maatpipet, 10 ml., gegradueer
†884 Vysel en stamper, volledig
†885 Pypaardedriehoek, 2"
†886 Retort, glas, 125 c.c. met buis en prop
†887 Retortklamp, met knobbel
†888 Retortstaander met twee ringe
831 Gomlastiekpyp 17/64" binnemaat, 6 Vt. lengtes (pas op 800B en 796)
794 Gomlastiekpyp 3/32" binnemaat 3 Vt. lengtes (pas op 824 en 825)
889 Saagies, glassny-, (3 per pakkie)
795 Skoppie, politeen
*816 Proppe, Kurk, ½", met gat (pas op 833 en 834)
*798 Proppe, Kurk ½" (pas op 833 en 834)
*890 Proppe, Kurk, (pas op 835 en 878)
*891 Proppe, Gomlastiek, (pas op 833 en 834)

†799 Spiritusbrander, glas, met pit
840 Borseltjie
*833 Proefbuise 3½" x ½"
*834 Proefbuise 4" x ½"
*835 Proefbuise 5" x ¾"
892 Proefbuise 6" x 1" (Hittebestand)
836 Proefbuishouer, metaal
†893 Proefbuisklampie, hout
894 Proefbuisstaander, plastiek
†895 Proefbuisstaander, hout.
896 Termometer, Celsius, −10° tot 110°
897 Termometer, Fahrenheit, 0° tot 240°
898 Termometerbuis, oop
†838 Driepoot
839 Horlosieglas
†841 Draadgaas 4" x 4"
899 Draadgaas 5" x 5" met asbeskol

†Afbeelding op volgende bladsy *Minimum 1 dos.

CHEMIKALIEË

842 Aluin
843 Ammoniumchloried
844 Houtskool, bleik
845 Kobaltchloried
846 Koperoksied
847 Kopersulfaat
848 Ferrosulfaat
849 Korrelsink
850 Ystervylsels
851 Yster (ferro) sulfied
852 Lakmoespoeier
853 Campêchehout
854 Magnesiumsulfaat
855 Mangaansulfaat
856 Marmerbrokkies (Kalsiumkarbonaat)
857 Nikkelammoniumsulfaat
858 Kaliumjodied
859 Gebluste Kalk (Kalsiumhidroksied)
860 Natriumbisulfaat
861 Natriumbisulfiet
862 Natriumboraat
863 Natriumkarbonaat
864 Natriumchloried
865 Natriumsulfaat
866 Natriumtiosulfaat
867 Wynsteensuur

BELANGRIK: Die Bunsen-brander kan net met steenkoolgas gebruik word en mag nie met aardgas of metaangas gebruik word nie.

Die bogenoemde apparaat en bybehore is beskikbaar by die naaste „Merit" -agent of, indien daar enige probleme ondervind word skrywe asseblief regstreeks aan:

J. en L. Randall Bpk., Potter's Bar, Herts. vir 'n opgawe van die heersende pryse en 'n bestelvorm.